

TUBERCULOSIS of the MIDDLE EAR in CHILDREN

with special reference to its occurrence as a

PRIMARY LESION.

by

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There are numerous considerations which combine to render Tuberculosis of the Middle Ear and Temporal bone a subject of great interest and importance both clinically and pathologically. The number and variety of the channels through which infection may take place, the frequency of the condition, its occurrence during infancy, the gravity of the condition and of its possible complications, the multiplicity of its symptoms and signs, the urgent need for drastic treatment, the possibility of absolute diagnosis and of ultimate cure are the most important of these considerations.

Important as the subject undoubtedly is, it is only recently that much attention has been paid to it, and even now its frequency and gravity are not duly appreciated, nor are its signs and symptoms sufficiently detailed in the current text books. Indeed many of them (even of those dealing exclusively with Diseases of the ear) pass it by altogether or treat it with a brevity which it ill deserves.

Before discussing the question in detail it is desirable that it should be understood that in the following paper the term 'middle ear' will be held to include not only the cavum tympani, but also the Eustachian/

Eustachian Tube and Mastoid Antrum. This is fully warranted by the anatomy and the developmental history of these cavities as has been recently demonstrated by Young and Milligan.<sup>1</sup> Owing to the difficulties in determining the primary site of the tuberculous process in these parts it is convenient to consider tuberculosis of the middle ear together with tuberculosis of the temporal bone; for it is rare that cases of the former come under our notice before there is some involvement of the bone and still less frequently do we encounter tuberculous caries of the temporal bone before some part of the middle ear is involved, except in cases where a temporal caries, unsuspected during life, is revealed on the post mortem table. That the two conditions can and do arise separately scarcely permits of doubt, but it is inconvenient for purposes of practical diagnosis and treatment to dissociate the two conditions.

Although the condition does not yet receive full recognition of its importance its occurrence has been recognised for many years.

The association of middle ear disease, and especially of chronic otorrhoea, with the scrofulous or strumous diathesis did not escape the observation of/

of the physicians and surgeons of the early part of last century; and was insisted upon when the diseases of the ear became the subject of special study and treatment. In the absence of the evidence which we now regard as a *sine qua non* in the verification of the diagnosis of the condition, it is necessary that the cases described by early writers and the conclusions they drew from them should be accepted with considerable reserve. In discussing chronic otorrhoea Wilde<sup>2</sup> states that in children it is to be regarded as indicative of the strumous taint and notes its frequent association with scrofulous glands in the neck. He records many cases of chronic middle ear inflammation and caries of the temporal bone in association with lesions elsewhere, the tuberculous nature of which we cannot doubt. There is obviously no reason why a patient suffering from a localised tuberculosis (e.g. of the lung or ankle) should not also suffer from a non-tuberculous otitis media, and we must therefore be careful in accepting an otitis media as being tuberculous in a patient suffering from tuberculosis elsewhere, unless we have full and definite evidence of the nature of the middle ear condition. The evidence in Wilde's cases is usually insufficient on this head. He gives notes however of a case which scarcely permits of/



of doubt as to its tuberculous nature, viz., that of a child aged 9, who for several years suffered from morbus *coxae* and in whom facial paralysis preceded by otorrhoea developed first on one side, then on the other, death finally supervening from cerebral disease (tuberculous meningitis?)

Wilde also makes reference to the occurrence of otitis media in phthisis and suggests that infection spreads via the Eustachian tubes. He draws attention to two facts which have since been emphasized by practically everyone who has since written on the subject, viz. the occurrence of otorrhoea as one of the earliest symptoms and the absence of pain even in the presence of extensive disease.

Toynbee<sup>3</sup> writing seven years later clearly associates many cases of chronic otitis media with tuberculosis. He gives notes of many cases in which "scrofulous matter" was found in the tympanic cavity but in most cases his notes are insufficient for our purpose. The following cases may however be accepted as genuine cases of tuberculosis of the middle ear or temporal bone.

1. A boy aet 4. - post-mortem examination revealed/

revealed tuberculous meningitis with tuberculous deposit in the cerebrum. The tympanic cavity contained "scrofulous material."

2. A girl aet  $1\frac{1}{2}$  - post mortem examination shewed tuberculosis of the lungs and mesenteric glands and there was caries of the temporal bone. Patient had had otorrhoea for seven months.

3. A girl aet 15. - post mortem examination revealed tuberculosis of the lungs. The middle ear and mastoid were "scrofulous" and there was caries of the temporal bone. In life patient had had facial paralysis.

4. A man aet 44. - death from phthisis. Post-mortem revealed caries of the petrous temporal. In life he had suffered from partial facial paralysis and chronic otorrhoea. He also mentions two other cases in infants aged  $1\frac{4}{12}$  and  $1\frac{11}{12}$  in whom there were long standing otorrhoea and scrofulous glands in the neck. The condition of the other viscera are not mentioned in his post mortem notes on these two subjects.

It will be seen from what precedes that tuberculous disease of the temporal bone and middle ear was recognised many years ago and in spite of the absence of the conclusive proof afforded by the detection /

detection of the specific organism many of the recorded cases may be accepted as authentic.

Attention may be drawn to two points exemplified in the cases cited viz:- the occurrence of the condition in infancy and the association of facial paralysis with tuberculous caries of the temporal bone,- points to which full reference will be made later.

Other references to the condition are found in the writings of Nélaton, Rokitansky and others.

The discovery of the Bacillus of Tuberculosis by Koch in 1882 placed in our hands a means of diagnosing the condition with certainty. Efforts to discover the bacillus in the aural discharge, met with success in the hands of Eschle<sup>4</sup> (in 1883), Nathan<sup>5</sup> and others and more recently by Grimmer,<sup>6</sup> Milligan,<sup>7</sup> Wingrave<sup>8</sup> and others. The literature on the subject has grown apace, numerous cases have been recorded and analysed, and the symptoms, etiology and pathology have been elaborated by many observers.

In discussing the association of tuberculous otitis media with late phthisis Wilde suggested that the Eustachian Tube was the avenue of infection of the tympanic cavity. This has largely been accepted as /

as probable by subsequent observers, but the occurrence of many cases in which no pulmonary tuberculosis exists, and of cases in which the tuberculous process is confined to the temporal bone, point to the possibility of other channels of infection, and suggest that the tuberculous lesion in the middle ear or temporal bone may, in some cases, be primary and not secondary to tuberculosis elsewhere. Many cases of primary Tuberculosis of the middle ear or temporal bone have been recorded by Knapp,<sup>9</sup> Goldstein,<sup>10</sup> Williams,<sup>11</sup> Mc.Caw,<sup>12</sup> Oppikofer,<sup>13</sup> Jobson Horne,<sup>14</sup> Hurd<sup>15</sup> and others. It is not intended here to detail or to analyse these cases and the notes of the following cases are quoted briefly to indicate the nature of the recorded cases of the condition of which they are typical.

1. Case recorded by Jobson Horne<sup>14</sup>. A child aet 1½. History of wasting for seven months with otorrhoea for four months and cough for three months. When seen had facial paralysis, otorrhoea and swelling behind the ear. The swelling was incised and found to be a subperiosteal abscess beneath which was necrosed bone. The discharge from the middle ear contained Tubercle Bacilli. Death subsequently occurred from Miliary Tuberculosis.



2. Case reported by Hurd.<sup>15</sup> Child aet 1<sup>5</sup>/<sub>12</sub>.

Swelling over mastoid was lanced when patient was six months old. The wound refused to heal and later necrosis of the bone was found and microscopic examination of the granulation tissue shewed evidence of tuberculosis. Some months later the other ear commenced to discharge. The child showed no signs of Tuberculosis elsewhere.

3. Case reported by Knapp.<sup>9</sup> Child aet 5 years.

Patient had tuberculous ulcers connected with carious bone in the back, ankle, above R. eye and below L. eye. There was a granulating ulcer over the R. mastoid. This was operated upon, the bone being found carious. There was no sign of disease of the external meatus or of the cavum tympani (primary tuberculosis of mastoid.)

4. Case reported by Oppikofer.<sup>13</sup> child aet 6 months.

Discharge from the ear subsequent to measles. Patient had facial paralysis. Antrum contained pus. Granulation tissue from the cavum tympani shewed tuberculous changes. Death occurred seven months later from general tuberculosis - the lungs, larynx and meninges being affected.

An interesting case is reported by Freysing<sup>52</sup> in which there were multiple tuberculous tumours on the/

the skull together with tuberculous involvement of both tympanic membranes.

### ETIOLOGY.

That the condition should occur not infrequently in late phthisis need not surprise us when we recollect the channels of infection (vide infra). It is difficult however to estimate its frequency and the published statistics differ widely. Thus Schwabach<sup>16</sup> found aural suppuration in 8 cases out of 139 patients suffering from pulmonary tuberculosis. Moldenhauer<sup>14</sup> found 7 cases of middle ear suppuration in 294 cases of tuberculosis (pulmonary and otherwise). Among children the proportion appears to be much higher. Thus Carr<sup>18</sup> in 120 post mortems on tuberculous children found the middle ear and temporal bone tuberculous in 3 cases. Price Jones<sup>53</sup> in 21 cases of Tuberculosis in children examined post mortem found it in 2 cases.

Still<sup>19</sup> in the post mortem examination of 269 children dying from Tuberculosis found the middle ear tuberculous in 15 and of these he regarded the aural condition as primary in no less than 9. In a series of 25 post mortem examinations of tuberculous subjects at the Newcastle Sick Children's Hospital the writer<sup>44</sup> found evidence of the condition in the middle ear or temporal/

temporal bone in 7 cases, in two of which it was unsuspected during life. Schwabach<sup>20</sup> in a series of 26 post mortems on tuberculous subjects found the middle ear invaded in no less than 16.

Whilst it has been shewn that middle ear tuberculosis is more frequently a complication of phthisis with cavitation than of any other form of pulmonary tuberculosis, it is also a well established fact that in children cavitation occurs with much less frequency than in adults, indeed it rarely occurs in patients under seven and in infancy is almost a pathological curiosity. Under these circumstances we should expect to find aural tuberculosis less frequent in infancy and childhood than in adult life. The very reverse however is the case. Tuberculous otitis media occurs more frequently in infancy than in any other period of life. Indeed after the third or fourth year of life its frequency undergoes marked diminution and except as a complication of late phthisis it is subsequently a rare affection. Its frequency in infancy is well shewn by the figures shewn by Whitehead<sup>22</sup> who, analysing 100 consecutive fatal cases of middle ear disease, found that 12 were cases of tuberculous disease and that of these 12 no less than 9 were patients under 2 years of age; and in 8 of these the aural/



aural condition was primary, whilst of the three patients over two years of age all had extensive mischief in the lungs.

It has been maintained by Horne, Grimmer and Milligan that the condition is not infrequently primary in infants, a hypothesis which is exemplified in the cases and figures quoted above. It has been stated by Milligan<sup>21</sup> that of his hospital patients under 6 years of age suffering from suppurative otitis media between 50 and 60% suffer from tuberculosis of the middle ear.

Of the sixty eight cases the writer has been able to collect, no less than forty nine occurred in infants under 2 years of age.

The fact that the tympanic condition may be primary must not be overlooked in considering the etiology of the condition.

Tuberculosis in infancy and childhood is unfortunately only too frequent and it has largely been ascribed to invasion through the lymphatics of the alimentary tract, the principle vehicle of infection being assumed to be milk from tuberculous cows. It is even stated by Nathan Raw<sup>54</sup> that this is the almost universal mode of invasion in infants. It must not be forgotten however that so far as bacteriology is concerned the middle ear is to be regarded/



regarded as belonging to the upper respiratory tract, as has been emphasized by Goldstein<sup>10</sup> and others. If tuberculosis of the middle ear then is primary, it must be grouped in the cases of "respiratory" and not "alimentary" tuberculosis. The fact that the patients are most frequently infants, and that they are derived from a class who are not largely fed on cows milk lends support to the view that infection is via the upper respiratory rather than by the alimentary tract. It has been pointed out by Milligan that the condition is much more frequent in hospital patients than in the children of the upper classes. No doubt unhygienic conditions and overcrowding are important factors nor must we overlook the importance of tuberculosis in other members of the family with whom patient is in constant contact. Of our own series 6 had a family history of tuberculosis. Of the 5 cases under one year 3 were breast fed till admission and one had been fed throughout on patent foods.

In discussing the etiology it is necessary to remember this increased frequency in infancy in order if possible to determine whether there are any circumstances which render the middle ear more liable to invasion during this period of life.

The/

The occurrence of the condition in cases of tuberculosis involving other organs has been studied by many observers. It is stated to occur with greatest frequency late in phthisis when the sputum is most abundant and most likely to remain near the pharyngeal orifices of the Eustachian tubes owing to the diminution of the patients' expectorating power, i.e. when the chances of infection of the Eustachian tubes are at a maximum. Politzer<sup>23</sup> has shewn that it may arise during the last few days of life. It may indeed be merely a part of the general tuberculosis which closes the scene. Brieger<sup>24</sup> and Milligan<sup>25</sup> state that the middle ear is more liable to be infected secondarily to pulmonary tuberculosis than to tuberculosis elsewhere.

#### Channels of Infection.

To produce tuberculous lesions in the middle ear or temporal bone it is necessary for the bacillus to gain access to these parts, and this it may do by one or other of several channels. These channels are

- I. by means of air passing up the Eustachian tubes and mechanically conveying the bacilli to some part of the middle ear,
- II. by infection spreading up to the cavum or antrum via the Eustachian mucosa.
- III. /

- III. by infection spreading via the lymphatics from tuberculous lesions elsewhere.
- IV. by infection carried from tuberculous lesions elsewhere via the blood stream,
- V. by infection from the external ear.

The first named method may at first sight appear improbable. We can not, however, dismiss it without first duly considering the factors which may influence its occurrence.

I. The general anatomy of the Eustachian Tube is so well known and so accurately described in anatomical textbooks that it is unnecessary here to enter into all its details. Certain facts however may profitably be reviewed and emphasized in order that we may fully appreciate the possibilities of this line of infection. (See Diagram E.)

In the adult the tube is from 34 - 36 m.m. in length but in children it is very much shorter, being, indeed, in the new born infant less than 20 m.m. in length. Its width is comparatively greater in children than in adults and is even stated by Eitelberg to be actually greater. Hence any object lodging in the tube is more easily removed by currents of air in children than in adults. In children too the tympanic orifice lies lower and is comparatively larger/



larger than in adults and the pharyngeal orifice lies much nearer to the choanae and therefore to the currents of air by which air-borne bacilli may enter. It has been shewn by Young and Milligan that smoke insufflated into the Eustachian tube passes directly through the tympanic cavity into the mastoid antrum, and that air-borne bacilli may similarly gain entrance to the antrum is by no means an impossibility.

It is true that the bacilli will in the vast majority of cases tend to settle on the mucous walls of the Eustachian tube and be removed by the cilia lining it, but in the short, wide tube of infants there is a much greater possibility of the bacilli being driven beyond the tympanic orifice by such strong blasts of air as are produced by efforts such as sneezing, coughing etc.

Even in adults particles much larger than bacilli may thus gain entrance to the tympanic cavity, as is proved by the case reported by Haug<sup>25</sup> in which particles of snuff gained access to the cavum tympani in this method and set up a purulent otitis media. Similarly it is not impossible that minute particles of food may be mechanically insufflated into the tympanic cavity by the act of choking or vomiting and thus convey the bacilli into the cavity of the middle/



middle ear. It has been suggested by Milligan<sup>26</sup> that the movements of suction initiate currents of air along the Eustachian tubes and it is possible that this may partially explain the frequency of Jobson Horne tuberculosis of the middle ear in early infancy. It is obvious that this mode of infection is most liable in infants who are breast fed by phthisical mothers or who live in association with phthisical individuals.

In the production of the condition in late phthisis this method again appears probable. In the wasted condition of advanced pulmonary tuberculosis the tissues surrounding the tube are shrunken and atrophied and the lumen of the tube becomes wider than in health.(Habermann<sup>27</sup>). It has been shewn by Jobson Horne that aural tuberculosis is much more frequent as a complication of phthisis when there is cavitation than when the changes in the lung are miliary in type. The frequent coughing and the abundant sputum also render it likely that the particles of sputum may be driven through the tube into the tympanic cavity. It is at least suggestive that the condition should be so frequent in late phthisis and in early childhood, when the condition favouring this mode of invasion are at their maximum.

II. The second method viz:- invasion by spreading of the tuberculous processes along the Eustachian tube, is subject to the same conditions as the first method and would appear to be of more frequent occurrence than the first. The two methods are so closely connected that we can not entirely dissociate them. It is important to remember that the middle ear should be regarded as a part of the upper respiratory tract as has been insisted upon by Jobson Horne<sup>28</sup> and Goldstein.<sup>10</sup> The latter states that "over 79% of the inflammatory and infectious processes which involve the ear have their origin in the pharyngeal and naso-pharyngeal cavities." This line of invasion is regarded by Politzer as being the most frequent.

While tubercle bacilli driven into the tympanic cavity remain there, there is a greater possibility of them being removed from the Eustachian tube by the ciliary movement should they chance to alight on the Eustachian mucosa. Hence it follows that while there is a greater possibility of bacilli gaining access to the Eustachian mucosa there is also a greater possibility of them being removed before inciting tuberculous changes. It is possible however that under favourable conditions the bacilli may pass through the mucosa, without producing any lesion in it, to the lymphoid follicles which have been/

been seen and described by Gerlach in the mucosa lining the tubes in children.

The probability of Tuberculosis originating in this manner is enhanced by the occurrence of catarrhal changes such as are frequently produced in the exanthemata etc. Politzer<sup>28</sup> has frequently seen tuberculosis of the middle ear associated with enlargement of the cervical glands following on an attack of Scarlet fever.

In addition to the exposure of the orifice of the tubes to the current of the inspired air whereby air-borne bacilli may reach the Eustachian tube, there is also danger of infection of the tubes by spread of tuberculosis from adjacent structures. Primary tuberculosis of the nose and of the pharynx are both rare, except as complications of phthisis, and the chances of infection by this route appear to be remote; we must not forget, however, that the proximity of adenoid tissue to the pharyngeal openings of the tubes introduces another element of considerable importance.

The frequency with which adenoids are subject to tuberculosis has been variously stated by different writers. Thus Mc.Bride and Turner<sup>29</sup> examining the adenoids removed from 100 patients found evidence of tuberculosis in only 3 cases. They admit that this figure/



figure is very probably an under estimate. Pilliet<sup>30</sup> found tuberculosis in 3 cases out of 40 (7.5%). Dieulafoy<sup>31</sup> in 35 cases found tuberculosis in 7 (20%). Brindel<sup>32</sup> found evidence of tuberculosis in 8 cases out of 64 (12.5%); Gottstein<sup>33</sup> in 4 cases out of 33 (12%). Pfluder and Fischer<sup>34</sup> in 32 cases found tuberculosis in 5 (15.6%). Milligan<sup>35</sup> found it in 16%; Lartigan and Nicol<sup>36</sup> in 16%.

To obtain the above estimates histological and inoculation methods were employed. It is interesting to note that the most exact method - inoculation - gave the highest figure (Dieulafoy 20%).

It will be seen then that adenoids are by no means infrequently the seat of tuberculous lesions and that their presence may be an important factor in producing tuberculosis of the Eustachian tubes.

III. The third method of infection viz;- via the lymph stream, can occur only by extension against the lymph current from the glands through which the lymphatics of this area pass. Such extension has been shewn to occur elsewhere and we must accept its possibility in this area. Unfortunately the lymphatics of the middle ear are not fully known and our knowledge of their anatomy is very imperfect. Poirier and Cuneo<sup>36</sup> have shewn that the lymphatics of the tympanic cavity originate in a network from which branches run to the retropharyngeal glands, which/



which also receive the lymphatics of the Eustachian tube. These glands are two in number on each side and lie behind the pharynx, in front of the apices of the lateral masses of the Atlas bones (see diagram D.) In addition to draining the middle ear these glands receive afferents from the upper part of the pharynx and from the nasal fossae. Efferents run to the superior cervical glands associated with the Internal Jugular vein. It will thus be seen that these glands drain an area that is very exposed to bacterial invasion. When we recollect the frequency of posterior rhinitis, pharyngitis and Eustachian catarrh occurring in the exanthemata or as part of ordinary "colds" we are not surprised at the occurrence of inflammation or even suppuration of these glands. Clinically, however we find that this rarely occurs except in infancy and early childhood, and it is even stated that these glands undergo spontaneous atrophy towards the close of the third year. Prior to that, however suppuration in them not infrequently occurs and is the most frequent cause at this age of retro-pharyngeal abscess.

The wide area drained through these glands renders it difficult for us to appreciate the frequency with which Eustachian and Tympanic infections are/

are the cause of their enlargement. We must not however forget the possibility already hinted at of the middle ear and its adnexa being infected secondarily to tuberculosis of these glands. The association of tuberculosis of the middle ear with morbid condition of these glands is suggested by the age incidence.

Clinically tuberculosis of the middle ear is often associated with enlargement of the glands lying behind the ear over the mastoid process and also with those in the superior cervical chains. Indeed early involvement of these glands in the course of chronic otitis media has been held by Grimmer, Milligan and others, to be indicative of the tuberculous nature of the middle ear condition.

IV. Infection through the blood stream from a tuberculous focus more or less remote is of the utmost importance. Barnick<sup>34</sup> has shewn that this method occurs most frequently when the primary lesion from which infection takes place, involves some part of the glandular or osseous system. It is precisely these two forms of Tuberculosis which are most frequent at the age in which tuberculosis of the middle ear is most frequently met with. Such a mode of extension implies that the condition may not of necessity be in the tympanic mucosa itself. In fact cases/

cases originating in such a method in all probability usually arise as an osteomyelitis of the petrous or mastoid portions of the temporal bone, and involve the middle ear by extension. Such a method would fully explain the occurrence of cases in which the pars mastoidea is extensively affected while the Tympanic Cavity remains unaffected, though such an occurrence permits of another explanation as has been pointed out in the discussion of infection through the Eustachian tube.

There are many phenomena associated with the condition which favour this mode of origin. The age incidence is important for it is undoubted that blood infections are more frequent in childhood and in infancy than later in life, as also are tuberculous affections of the bones.

It can be shewn that not only is tuberculosis of the bones more frequent during early life but also that certain bones are more frequently affected at certain ages. Thus Dactylitis is most frequent during the first two or three years of life. During a year at the Newcastle Sick Children's Hospital fifteen cases of spinal caries were admitted for treatment. of these fifteen, twelve were cases of cervical (or upper dorsal) caries and all occurred in children between/



between 2 and 5 years of age. The other three cases occurred in children above this age and the lumbar ~~of~~ lower dorsal spine was affected. To generalise on such small numbers would be to court fallacy but these figures were supported by the out patient statistics, and a <sup>me</sup> number of the Honorary Staff, who had been associated with the Hospital for fifteen years, informed the writer that he had constantly made the same observation. Cervical caries most undoubtedly occurs at other ages and may occur at any age, but its frequency certainly seems to be greatest during the period stated. Without pressing the point too far it may be possible that the occurrence of such a large majority of the so-called primary cases of tuberculosis of the petrous temporal and mastoid in the first and second years of life may be associated with a similar condition.

In this connection it may be mentioned that the stapes is more frequently affected in tuberculous conditions than in any other form of middle ear inflammation. This ossicle developes round the stapedia artery which usually atrophies and disappears during the development of the ear towards the close of pregnancy; not infrequently however it persists for sometime after the commencement of extra uterine life/

life and may thus be the means of carrying blood borne bacilli to the middle ear. In addition to the age incidence the occurrence of extensive caries is of importance. Many cases when first under notice shew extensive caries of the temporal bone, a fact which might be ascribed to the absence of symptoms produced by the condition until by extension the tympanic cavity has been affected.

Milligan thinks that the osteomyelitis tends to remain as such until secondary septic processes occur in the tympanic cavity or antrum. It is believed by Cornet,<sup>38</sup> on the other hand, that caries of the temporal bone is generally secondary to affection of the tympanic mucosa.

Associated with this early and extensive caries is the production of facial paralysis, which may be one of the earliest noted symptoms, and, indeed, may be the symptom for the relief of which the surgeon is first consulted.

That such a mode of infection exists permits of no doubt. The case reported by Knapp<sup>9</sup> is undoubtedly of this nature, as also, in all probability, is that mentioned by Wilde<sup>2</sup> and quoted above and that of Hurd.<sup>15</sup> The occurrence of tuberculous deposits in this region in acute miliary tuberculosis has been noted. It is however of no practical importance.

V. The establishment of Tuberculosis of the middle ear by invasion from the external meatus may occur, but in all probability is of rare occurrence. In cases however where there has been perforation of the drum owing to previous otitis media etc. it is not impossible that the introduction of foreign bodies into the ear may give rise to tuberculosis of the middle ear, if the foreign body should happen to be the vehicle of Tubercle bacilli. Obviously this line is most important in children among whom foreign bodies are frequently introduced into the ear.

#### PATHOLOGY.

The tubercle bacilli having gained access to the middle ear these give rise to the tissue changes characteristic of tuberculosis. These changes were described by Politzer who in 1882 described the histological condition of the mucosa lining the middle ear of a woman who died from Phthisis complicated by middle ear mischief.

In this case the mucosa was already largely destroyed and the bone was extensively affected. Habermann<sup>29</sup> examined thirteen cases and found all degrees of the condition, from early infiltration down to extensive destruction of the temporal bone and/



and the researches of Barnick<sup>34</sup> and of Schwabach have thrown further light on the changes that occur.

The changes induced differ somewhat according as the condition runs an acute or a chronic course. In the acute form there is the deposition of numerous tubercles leading to ulceration with rapid loss of tissue - perforation of the membrana and rapid formation of granulation tissue. The primary grey tubercles may be occasionally observed on the membrana tympani where they are frequently multiple, as has been described by Politzer and others. Milligan<sup>35</sup> has been able to detect them on the mucosa of the cavum tympani through a semi-transparent membrana. Although they ... so soon lead to perforation of the drum they have been described by Politzer before this occurs as pearly spots with sharply defined outlines and with very little surrounding inflammation, though in some cases the entire drum may have a pink tint.

and

They rapidly cause perforation, if the tubercles are multiple, they may, by coalescence, form a single large perforation, or they may remain discrete for some considerable time. The occurrence of multiple perforations is a point of considerable diagnostic importance and will be more fully referred to later. Owing/

Owing to the occurrence of perforation and to other causes it is usual for septic and putrefactive organisms to gain entrance and to speedily modify the pathological processes.

While the acute form is a well established entity, it is more usual for the condition to run a chronic course, and it is this chronic tuberculous condition which presents the most typical picture.

Owing to the intimate connection between the temporal bone and the tympanic mucosa (the deeper layers of which, indeed, fulfil the functions of periosteum to the underlying bone) the occurrence of tuberculous changes in the mucosa early leads to tuberculous infection of the bone, in which a cario-necrotic change is instituted. The process of the ulceration of the tubercles in the mucosa leading to caries of the underlying bones has been fully described by Milligan. The caries progresses rapidly, and, as in tuberculous caries elsewhere, is not productive of much pain, indeed the absence of pain in this condition - to which full reference will be made later-is typical of this form of middle ear disease.

The reaction of the tissues excited by this form of chronic tuberculous invasion is not intense, and hence/

hence, instead of the hyperaemic injected mucosa associated with an acute otitis, we find pale ulcerated mucous membrane with profuse flabby granulations which fill the cavum and may project through the perforated drum, and even form polypoid masses in the external meatus. These granulations may shew typical tuberculous changes, such as giant cell formation and caseation, as has been observed by Milligan and Hurd.

The caries extends steadily and meets with no barrier to its progress until dura mater or periosteum is reached. The dura is rarely perforated but tends as in cases II, X, to be thickened and indurated at such places as the caries approaches the surface.

The extension of the caries is of great importance in the production of complications which may arise from implication of structures within the temporal bone. Thus the extension to the Fallopian aqueduct may cause facial paralysis, partial at first, from neuritis, and later complete, from destruction of the facial nerve. The production of this complication is favoured in infancy by the incomplete ossification of the walls of the aqueduct which do not offer so much resistance to the disintegrating processes as they do when ossification is complete.

Similarly/



Similarly the labyrinth may be infected and complete nerve deafness, or - by involvement of the semi-circular canals - vertigo of a persistent type, may be produced.

Caries of the ossicles occurs with considerable frequency. In no other middle ear condition are they so frequently destroyed. Caries of the foot of the stapes is considered by Haik<sup>40</sup> to be pathognomonic of tuberculosis. If this occurs the fenestra ovalis is soon destroyed and again involvement of the labyrinth occurs. Perforation of one or other of the fenestrae has been stated to occur in 33% of cases.<sup>35</sup>

Mention has already been made of the possibility of the Stapes being the primary site of infection so far as the middle ear is concerned in early infancy. Though the bony changes are usually of the nature of a gradual molecular disintegration, necrotic changes may occur, and large sequestra be found, as in a case described by Goldstein.<sup>10</sup>

In addition to the involvement of the nervous apparatus, blood vessels may be eroded and haemorrhages occur, which may even be of an alarming character. Kössel<sup>41</sup> has described a case in which thrombosis of the lateral sinus was produced. A similar/

similar case is included in the series below (case VI) but there is every reason to believe that the thrombosis of the sinus was due to the presence of septic organisms and not to the Tubercle bacilli, though the latter were also present in the middle ear. Cheattle<sup>55</sup> has pointed out the importance of the petro squamosal sinus as a channel of infection from the middle ear in infants, and records a case in which general miliary tuberculosis was so produced.

The occurrence of Mastoiditis is not infrequent, and, as has been shews by Knapp, Jobson Horne, Hurd and others, the Antrum may be affected before the Tympanic cavity shews any signs of the condition. This appears more likely in such cases as the condition commences as an osteomyelitis of the pars mastoidea, but does not depend entirely on this mode of origin, as it has been shewn by Young and Milligan that in cases of infection through the Eustachian tube, mastoiditis may occur independently of inflammation of the cavum tympani.

Owing to the early perforation of the drum, other organisms gain access to the tympanic cavity and alter the course of the tuberculosis. Hence it is difficult to follow the later changes of the condition. The invasion of other organisms introduces a further difficulty in diagnosis, for the/

the bacilli of tubercle are apt to be disintegrated and broken up or destroyed in the profuse discharge which is associated with the presence of putrefactive organisms. Hence the great difficulty in detecting the bacilli in stained films of the discharge in which they are never abundant except in some acute cases.

The presence of tubercle in the middle ear soon leads to enlargement of the neighbouring lymph glands in which the chronic inflammatory changes associated with typical tuberculous lesions, viz:- formation of tubercles, giant cell formation and caseation - occur. These changes appear to be usually produced first in the mastoid glands, from which subsequently the deep glands in the neck are infected. Glands in the parotid region may also be affected as in case XI, and the retropharyngeal glands are also liable to infection. In the present series they were only in one case enlarged sufficiently to cause symptoms (case III.), but whether the glandular condition was secondary to the middle ear condition cannot be stated with certainty, for the tuberculous condition of the ear was only discovered at the postmortem, some months after the retropharyngeal glands became enlarged.

It/



It is affirmed by Jobson Horne<sup>42</sup> that early glandular enlargement occurs in primary tuberculous conditions of the middle ear but that the glands rarely become involved in cases where the tuberculous condition of the ear is secondary to tuberculosis elsewhere.

Infection of the meninges is not infrequent as a complication which may be the ultimate cause of death. Macewen<sup>43</sup> alludes to ten cases in which it occurred, in five of which the line of infection was via the Internal Auditory Meatus. He has also found it produced by miliary tuberculosis resulting from infection of the Lateral Sinus.

Owing to the late union of the petrous and mastoid portions of the temporal bone, meningeal infection is more likely to occur in infancy than later. The meningeal condition is not infrequently merely a part of a general miliary tuberculosis caused by blood infection to which infants during the second year of life are so prone. In the present series general miliary tuberculosis was the cause of death in four cases (Nos. I, II, III, X.), while meningitis only occurred in one (No. V.) in which case unfortunately permission for post mortem examination was not obtained.

Mention/

Mention is frequently made of this complication throughout the literature and cases in which it has occurred are recorded by Wilde, Milligan, Oppikofer, Toynbee and others. Horne<sup>42</sup> states that this complication is not infrequent in cases of primary tuberculosis of the ear, but that its occurrence in cases where the tuberculosis of the middle ear is secondary is uncommon. On the other hand it is affirmed by Politzer<sup>24</sup> that intracranial complications are less frequent in tuberculous than in any other form of chronic middle ear infection. The occurrence of tuberculous abscess within the cranium is rarely seen. In the present series intracranial complications occurred in two cases only (V, VI,) in one of which there is reason to believe that this complication was associated with the presence of streptococci. An interesting case in which optic neuritis appeared is recorded by Wingrave.<sup>56</sup>

The extension of the carious processes in the other direction often leads to formation of subperiosteal caseation and abscess formation. If the pars mastoidea be affected this may occur just over the Antrum and cause the appearances of an antritis or, by extension inwards, Bezold's perforation may ensue.

On/

On cutting down over the swelling in such cases a fistulous track filled with unhealthy granulations and caseous debris, and leading down to the antrum, is found, as in cases I, II, III, IX, X. If left untreated these mastoid abscesses may burst externally and discharge through the skin leaving a chronic indolent fistula shewing no signs of healing.

The facts that the Eustachian tube is shorter and wider in infants than in adults, and that the tympanic orifice lies lower and is of larger size, points to the probability of the thin sanious discharge draining from the middle ear into the pharynx, from whence it may be swallowed and so convey bacilli into the lower alimentary tract. This may account for the frequency with which enteritis occurs as a complication, - a complication to which Milligan has drawn attention. Such a condition would account for the frequency of diarrhoea among these patients though such a symptom may in many cases be due to general conditions rather than to local tuberculous inflammation.

While it will be seen that the complications of the tuberculous processes are many, it is doubtful if the condition even undergoes spontaneous cure. Politzer even casts doubt on the authenticity of cases reported as cured by radical operative interference.

While/



While it appears doubtful that cases occurring in late phthisis should be curable, it is not impossible that radical measures may actually cure some primary cases. It must be remembered that these cases have been shewn to occur at an age when rapid and widespread dissemination of tuberculosis occurs, and it is impossible in many cases to be certain that the aural condition is the only existing focus of infection. Indeed owing to the slowness with which the condition declares itself and the asthenic character of the inflammatory processes induced by it, it is probably infrequent for such cases to come under observation before such dissemination has already commenced.

#### SYMPTOMS.

The symptoms produced by the condition are numerous and varied. In considering them it is advisable to deal separately with the general symptoms and with those which are dependent on local conditions. The general symptoms are, broadly speaking, those of tuberculosis generally. It is remarkable however that these may be absent in some cases where the local disease is extensive, Amongst the most prominent of the signs and symptoms must be placed wasting. Not infrequently this may have been/

been noticed some time before the local condition declares itself, and in some cases the patient is originally brought to a physician for the relief of this symptom. While the wasting process may be extensive it must be admitted that many cases are seen in which general nutrition is good throughout (see case No.XII). It is not improbable that the wasting is most marked in cases where the tuberculous process is generalised, and where there is more than one focus of disease (see cases No.VII, IX); at the same time it has been met with to a marked degree when the aural condition is primary and where dissemination only occurs in the final stage of the condition. (see cases X, I.) We have no reason to doubt that this symptom is due to the general effect on nutrition caused by absorption of the tuberculous toxin rather than to any local factor. In some cases this wasting is augmented, if not caused, by the occurrence of intractable diarrhoea. This appeared in some of Milligan's cases and was well-<sup>marked</sup> reached in case No.I of the present series. It may occur early or be a late symptom.

The appearance of the patient is in many cases suggestive of tuberculous mischief. The dryness of the skin, which has frequently been noted in tuberculous peritonitis etc. is in some cases very marked/

marked, and cannot in every case be accounted for by the existence of the diarrhoea.

The presence of rashes on the skin has not apparently been noted by other observers, and if present it is improbable that they are due to the local conditions but rather to a general toxæmic condition. One case (No. I) of the present series developed, a few days before death, a general erythematous rash lasting for a day or two and then subsiding. It was followed by severe diarrhoea and it was found postmortem that miliary tubercles were present in the Lungs and Spleen.

In two cases of the series (Nos. II and IX) scattered petechial haemorrhages occurred in the skin. They were few in number, occurred irregularly and shewed no typical localisation. In both cases they appeared several weeks before death occurred, and in only one of the cases was there evidence of miliary tuberculosis; in both cases however there were caseating tubercles in the Spleen. In case II these spots were noted two months before death and there was a large eruption of fresh haemorrhagic spots a few days prior to death. The occurrence of these spots cannot have any causal association with the aural condition but rather with some hæmic condition caused/



caused by the dissemination of the tuberculous virus and as such their occurrence has a grave significance.

The temperature chart of a patient suffering from aural tuberculosis displays nothing that can be recognised as typical. In cases uncomplicated by tuberculosis of other organs there may be little or no rise of temperature (see Chart I.), as might be expected when we recollect the asthenic character of the condition. The presence of other organisms however tends to cause elevation and irregularity of the temperature. In cases where miliary dissemination supervenes we may see evidence of its occurrence in rapid alteration of the type of the temperature curve (see charts IV and V.)

In cases where there is extensive caseating tubercle, either locally or in some other organ, the typical swinging temperature may be observed particularly when there are numerous foci (see chart III). Some primary cases (see chart II) also display marked irregularity of temperature.

Consideration of the pathological processes involved and of the complications to which the patient is liable give many indications of the symptoms which we may expect in this condition.  
In/

In acute cases the symptoms are those of an acute otitis media, and nothing pathognomonic is noticed for some time, and it is frequently not until the condition has entered a chronic stage that suspicion is aroused by enlargement of the lymph glands, facial paralysis etc. In chronic cases the essentially asthenic nature of the processes fully account for the absence of pain, or at least the slight character of the pain, from which the patient suffers. This absence of pain has been commented on by everyone who has studied the condition. It has been suggested by Urban Pritchard<sup>45</sup> that this absence can be accounted for by the absence of pressure on the nerves, the early perforation of the membrana preventing the presence of increased tension in the cavum tympani. On the other hand it has been suggested by Jobson Horne<sup>42</sup> that the absence of pain is due to the anaesthetic action of the decomposition products of the waxy envelope of the bacilli themselves. The absence of pain is not found only in this condition, tuberculous osteomyelitis in any long bone is rarely accompanied by acute pain unless other structures are involved.

The occurrence of discharge from the ear is not infrequently - in the absence of pain - the earliest symptom noticed. This discharge presents many points, /

points, apart from its chronicity and the absence of associated pain, which may justly raise suspicion that the case is tuberculous. In many cases the discharge is thin and sanious, in others it is thick and curdy with a foetid odour. In the majority of cases the odour is offensive, this character being due to the presence of putrefactive organisms which gain access subsequently to the perforation of the drum. In cases where there is extensive caries of the bone the odour assumes a peculiar foetid character which is easily recognised. Not infrequently the discharge is blood stained and in many cases this persists after it once obtains and may be associated with the presence of caries.

In many cases small spicules of bone have been discharged and the discharge may have a gritty feeling from their presence. It may even contain distinct bony sequestra which have been exfoliated as in a case described by Goldstein.<sup>10</sup>

It has already been mentioned that the ulceration of the tubercles leads to early perforation of the membrana. This occurs early in the disease and not infrequently has already occurred before the patient first comes under notice. Owing to the fact that there may be more than one tubercle on the drum it is not/



is not infrequent for the perforation to be multiple, as has been described by Politzer, Grimmer, Milligan.

By an extension of the ulceration the perforations may coalesce and produce a single perforation of large size, indeed the drum may be almost entirely destroyed when the patient is first seen ( see cases II, V, X, XI, VII). In addition to the multiplicity of perforations their position and appearance may be characteristic. Thus Blake and Buck<sup>46</sup> regard the presence of perforation in the posterior superior quadrant as almost pathognomonic of tuberculosis. The perforations are not surrounded by any marked zone of inflammatory redness for as has been pointed out the process is essentially asthenic.

Through the perforations in the drum granulation tissue may be seen. These granulations are more marked than in any other form of otitis media. In many cases they may be seen to almost completely fill the *cavum tympani*. They are flabby and unhealthy and bleed readily. From them sanious, foul smelling discharge issues. They frequently shew evidence of active tuberculosis and caseous areas have been seen in them by Milligan and Hurd.<sup>35</sup>

The early occurrence of caries has already been mentioned./

mentioned. In such cases as the processes commences as an osteomyelitis it may be very extensive when the patient is first seen, indeed in some cases the mastoid and petrous portions of the temporal bone may be reduced to a mere shell of bone as in cases V, X. Milligan has described a case in which this occurred on both sides, a thin lamina of bone supporting the middle cranial fossa being all that remained of the temporal bones. In many cases the carious condition is so obvious that it requires little demonstration. Though usually covered by granulation tissue this is not always the case and carious bone may be actually visible through the external auditory meatus. A probe passed carefully into the **cavum** will frequently reveal the gritty, sugary nature of the bone beneath the easily-torn soft granulations. In advanced cases a probe so passed may not encounter any obstruction until the apex of the petrosa is reached, thus in case No.X. a probe could be passed in horizontally for a distance of more than 2 inches from the external meatus before carious bone was touched. The caries may affect the ossicles as has been already mentioned and they may be completely destroyed or become detached and escape in the discharge. The frequency with which the **Stapes** is affected/

affected and its diagnostic significance have been already alluded to. In many cases - particularly where there has been an osteomyelitis of the pars mastoidea - the caries involves the outer wall of the antrum and leads to the formation of a subperiosteal abscess over the mastoid. Should this burst externally a fistula may be left extending from the skin to the antrum. (See Diagram C.)

The production of facial paralysis is easily understood when we recollect the course taken by the VII cranial nerve in traversing the temporal bone. Seeing that the process producing the paralysis is itself usually of a chronic nature, it might be expected that the paralysis would itself be of gradual onset. This however is not always the case; often the paralysis occurs quite suddenly as in cases II, V. In such cases the paralysis is usually complete but is not invariably so. Even though the facial nerve be affected in the aqueduct some of its fibres may escape. In a case observed by the writer in an infant of four months there was a slight paresis of the orbicularis palpebrarum on the right side but no other evidence of facial involvement. Post mortem examination shewed the presence of caries of the pars petrosa, the facial nerve apparently crossing/



crossing this area intact. The tuberculous nature of this case could not be demonstrated and the case is not included in the present series, but that a tuberculous caries might produce similar partial paralysis may be accepted as highly probable. The absence of lines in the face of an infant sometimes makes it more difficult to detect slight degrees of facial paralysis as it does not manifest itself during repose. Its presence had not been noticed by the guardian of case No.VII in whom the paralysis was nearly complete. The involvement of the VII cranial nerve also leads - by implication of the fibres supplying the chorda tympani - to impairment of the sense of taste. It is obvious, however, that this symptom is of little value in cases occurring in infancy. It has been noticed, however by Politzer in adults.

The labyrinthine symptoms are important, though not pathognomonic, and their production will be readily understood from the consideration of the pathological processes. Owing to the existence of caries bone-conduction of sound is early impaired. The inner ear is liable to infection not only by extension of the caries but also - in an especial degree, - by invasion through one or other of the fenestrae. The frequency of infection of the stapes/

Stapes predisposes to this. It is stated that perforation of one or other window occurs in 33% of cases.<sup>35</sup> The involvement of the internal ear in the tuberculous processes quickly leads to nerve deafness which is frequently absolute. The high degree of deafness in tuberculous middle ear disease has been pointed out by Horne<sup>28</sup> and Milligan.<sup>35</sup> The occurrence of nerve deafness from involvement of the VIII cranial nerve or cochlea becomes of grave significance when we recollect that in five of Macewen's cases this was the path by which the meninges were affected.

The last symptom to which attention is drawn - enlargement of the lymph glands - is certainly not the least important. The glands most usually involved are, as already mentioned, the mastoid, retropharyngeal and parotid. Subsequent to the infection of these glands, the glands in the deep cervical chains become involved and form large masses as in cases I, II, VII, X, III. It is important to note that these glands may be considerably enlarged before the middle ear condition manifests itself by facial paralysis, otorrhoea or other symptoms; and indeed the presence of large glandular masses in the neck may be the first indication of any departure from health (as in case I, II).

The/

The early enlargement of the glands in tuberculous cases is the rule and it is stated by Milligan<sup>35</sup> that cases of tuberculosis of the middle ear are rarely seen without this symptom. According to Jobson Horne<sup>42</sup> the glands are rarely affected in cases when the ear is affected secondarily to other lesions, but their enlargement is a constant feature of primary affections of the ear.

### Diagnosis.

In discussing the symptoms it will be seen that these are not peculiar to the condition under consideration. It is important therefore that we should endeavour to appreciate the relative value of these symptoms in order that they may enable us to arrive at a diagnosis. Whilst the symptoms are of doubtful diagnostic value individually, collectively they build up a picture which cannot easily be mistaken. It frequently happens however that the picture is not sufficiently complete until the patient is "the mere despair of surgery," and it is therefore necessary to see what symptoms are of special diagnostic importance in order that appropriate steps may be taken to eliminate the disease early in its course.

The/



The multiplicity of perforations, the absence of inflammation surrounding them and particularly their presence in the posterior superior quadrant (Blake & Buck<sup>46</sup>), have been emphasized as of special importance. In some cases tubercles have actually been seen on the membrane or through the membrane, on the internal wall of the tympanic cavity, and in such cases the diagnosis should be readily made.

The absence of pain is important for no other middle ear condition is associated with such extensive destructive changes unaccompanied by pain. Pain is also absent in sarcomatous conditions and this possibility must be borne in mind though other factors should suffice to distinguish the two conditions.

In no other condition does Facial paralysis occur so early or with such frequency. It occurred in 45% of Milligan's<sup>58</sup> cases, while in his non-tuberculous cases he only observed it in 2%. We may contrast this high percentage with the figures of Lake,<sup>47</sup> who in 658 consecutive cases of suppurative otitis media only encountered facial paralysis in 4. The presence of this sign is regarded by Grunert<sup>59</sup> as almost pathognomonic of tuberculosis in cases of chronic otorrhoea. The only other condition in which it occurs with similar frequency is sarcoma of the temporal bone.<sup>48</sup>

The/

The character of the discharge - foul and sanious; the early enlargement of the neighbouring glands (in primary cases), and the occurrence of an indolent fistula over the mastoid are all points which have a special significance. In such cases as it can be detected the presence of stapedial mischief has been pointed out by Haike<sup>40</sup> as indicative of a tuberculous condition. The presence of profuse granulations is regarded by Gaudier<sup>60</sup> as a suspicious sign.

Jobson Horne<sup>42</sup> emphasizes the diagnostic importance of marked loss of hearing power and also insists on the usual absence of headache and on the occurrence of haemorrhages; while Politzer<sup>24</sup> lays stress on the rapidity with which the membrana is destroyed and on the importance of the detection of carious bone on the inner wall of the cavum..

When upon examination we find the membrana almost completely destroyed, the cavum filled with unhealthy granulations, beneath which gritty bone can be felt, or when bare carious bone is visible, we cannot but strongly suspect the condition to be of a tuberculous nature, especially when the patient is an infant.

The discovery of the Bacillus of tubercle by Koch placed/

placed in our hands a method of diagnosis of greater, and even of absolute certainty. If the condition be due to tuberculosis we should expect to find the specific bacillus in the discharge. This was first done by Eschle<sup>44</sup> in 1883 and has since been done by many observers. Nathan affirmed that he was able to detect it in every case, but certainly most observers have been less fortunate, and there are undoubtedly cases in which the bacillus is not present in the discharge.

Since the discovery of the bacillus in the discharge by ordinary microscopic examination depends on its acid-fast staining reactions, it is important that we should realise that numerous other bacilli possess this reaction, which has been shewn to be due to the presence of an envelope of a waxy nature surrounding the bacillus.

Of these the best known are B. Leprae, B. Smegmae, B. of Timothy grass, the Butter Bacillus. To these must be added others. Wingrave<sup>49</sup> in discussing the question relative to the occurrence of B. Tubercle in the aural discharge draws up a list of eight bacilli, known to have acid fast properties.

These include those already mentioned and also B. of Syphilis (Lustgarten) and some bacilli associated with pulmonary gangrene, fetid bronchitis and/or



and bronchiectasis. It is important to remember that many of these possess characters in which they differ from B. Tubercle. Thus the B. Smegmae is only found in the secretions of the external genitals and is easily bleached with alcohol. B. Leprae practically never occurs in this country. Lustgarten's Bacillus of Syphilis is doubtful. The Butter Bacillus is probably a "grass bacillus," allied to that of Timothy grass.

The acid fast properties of the bacilli associated with pulmonary gangrene and bronchiectasis have been attributed by Fraenkel<sup>50</sup> to their occurrence in a medium rich in fats and fatty acids produced by putrefactive changes. It will thus be seen that the probability of acid fast bacilli found in aural secretion being identical with the B. Tubercle is great. In a series of 100 cases examined by Wingrave<sup>49</sup> 24 shewed acid fast bacilli in the aural discharge, and the inoculation test shewed that these were B. Tubercle in 17 cases. It is interesting to note that of the remaining seven cases five were patients suffering from tuberculosis elsewhere.

It has been shews that the acid fast reaction is due to the presence of a waxy envelope surrounding the bacilli.<sup>51</sup> When we recollect that the same reaction/

reaction is possessed to a high degree by the squames found in some cases in the middle ear secretion (see Diagram A.) and that the secretion of the external ear consists largely of a waxy material, we at once see a possible source of error in relying on the detection of B. Tubercle by its staining reactions only. It is possible that bacilli which are not normally acid fast should acquire this property adventitiously as a result of their growth and existence in a medium rich in waxy bodies. Thus Fraenkel<sup>50</sup> has shewn that the Bacillus which shews acid fast properties in the secretions of pulmonary gangrene loses this property when cultivated on media in which fatty bodies do not exist. It is noticeable however that we have never met with acid fast cocci in the aural discharge, though they are subject to the same conditions and grow in the same waxy medium and therefore might be expected to acquire this reaction wherever we find that the bacilli have acquired it adventitiously.

In order to obviate so far as possible these sources of error it is advisable that the discharge to be examined be taken only from the deepest accessible source, and then only after the cavity has repeatedly been flushed out. Films shewing the/  
the/

the presence of acid fast squames should be discarded, for it has been pointed out by Wingrave that particles of these squames when broken up may be mistaken for B. Tubercle.

In many cases it is possible to obtain scrapings from the granulations and in them the B. Tubercle may be found in considerable numbers. Histological examination of these granulations may shew the presence of caseation or giant cell formation.

While it has been shewn that some cases are not tuberculous yet shew acid fast bacilli in the discharge, the method fails in a far larger number of cases through inability to detect the presence of B. tubercle in the discharge in cases which are undoubtedly tuberculous. The discovery of the bacillus is nearly always attended with considerable difficulty and in the majority of cases it is only after prolonged search through several films that they are detected. It is stated by Brieger that the bacilli are not not infrequently absent from the discharge.

In some cases however this difficulty disappears and the bacilli are met with in considerable quantities (see Diagram B.) This usually occurs in acute cases and early in the condition, for as has been pointed out the bacilli are frequently destroyed in the putrefactive changes instituted by other organisms.

Examination/



Examination of the neighbouring lymph glands may shew the presence of typical tuberculous changes and thus clear the diagnosis.

If doubt still exists after microscopic examination of the discharge our final court of appeal lies in the experimental inoculation of animals, as has been successfully practiced by Milligan who, by this means, obtained positive proof in eight out of ten cases submitted to this method. (It is of interest to note that of these ten cases the two failing to respond were patients aged 11 years and 19 years, while of the eight from which positive results were obtained all were under 3 years.)

This method involves time and is frequently impracticable except in hospitals associated with pathological laboratories. For practical purposes then we must rely on the clinical history, the symptoms and local appearances, and the microscopical examination of the discharge as the joint foundations of our diagnosis, and in most cases these together give sufficient data. In cases of chronic discharge from the middle ear occurring without pain and associated multiple perforations or destruction of the membrana, caries of the temporal bone, facial paralysis/

paralysis or enlargement of the lymph glands, we may accept the presence of acid - and alcohol - fast bacilli in the discharge as proof of the tuberculous nature of the disease with confidence.

Case I. M.H. aged 9/12. When patient was 7 months old a swelling was noticed behind and below the right ear. Patient was youngest of three. The other two had not shewn any signs of tuberculosis. Parents healthy. The mother's brother died of Phthisis. Patient was breast fed entirely until admission. No history of previous illness except chickenpox some months ago and slight cough and diarrhoea just prior to present illness.

On admission - general condition poor. Marked swelling over mastoid and below it on R. side; discharge from R. ear. Glands below R' ear enlarged. The mastoid abscess was opened and the underlying bone found to be carious - a perforation into the antrum being found. This was opened up and the antrum and middle ear found to be filled with debris. The ossicles were lying loose and were carious, the membrana was almost entirely destroyed. There was extensive caries of the temporal bone. The carious bone was thoroughly scraped away and the antrum/


antrum and middle ear laid freely open. The posterior wound was closed and the cavity packed through the external meatus. Examination of the debris from the antrum and middle ear revealed tubercle bacilli in large numbers. Subsequently the local condition remained satisfactory, but patients general condition did not improve. Six days after operation temperature rose to 102.4 suddenly, an erythematous rash developed, diarrhoea and later a cough set in and patient died three days later. Immediately prior to death temperature rose to 105.2. (See Chart V.)

Post Mortem. The local wound was quite clean. The apex of the right petrous temporal bone was carious, a small collection of caseous debris in this position being separated from the middle ear etc. by a layer of apparently healthy bone. The left petrous temporal also had caries in the cancellous tissue. There was no meningitis and no thickening of the dura covering the temporal bones. The left lung shewed a patch of tuberculous bronchopneumonia in the lobe. There were miliary tubercles in the spleen and in both lungs. Examination of the other organs shewed no signs of tubercle.



Case II. M.G. aged  $\frac{3}{12}$ . Patient was healthy until three weeks before admission when he began to "go back" and a lump was noticed below the left ear. This increased in size and a week later complete facial paralysis set in suddenly. Three or four days later a discharge from the ear was noticed. No family history of tuberculosis. Patient was breast fed until admission.

On admission, - nutrition was fair. There was complete facial paralysis on the left side. Below the left ear were large masses of glands. Behind the ear there was a fluctuating swelling. Thick foul smelling discharge issued from the ear. Examination of the discharge revealed tubercle bacilli. Examination of the other systems revealed nothing of note. As the membrana was completely destroyed an attempt was made to improve the local condition by antiseptic flushing etc. There being no local improvement patient was operated upon (Dec. 21st). The enlarged glands - most of which were caseous were removed or scraped. The mastoid was exposed and found to be perforated. On opening it up it was found to be filled with caseous pus. The middle ear was also full of similar material/

material and the surrounding bone was carious. In the tegmen tympani was an irregular  shaped opening covered by thickened dura mater. The ossicles were lying loose and were very carious. The cavity was left freely open, all the carious material having been scraped away, and packing introduced through the external meatus. The cavity was subsequently syringed freely with peroxide of hydrogen until the discharge lessened after which it was kept quite dry. Seven days after operation temperature rose and cough developed and became incessant. Slight diarrhoea developed and some purpuric spots were observed on the trunk. Patient never rallied and died January 13. (See Chart VI.)

Post Mortem. The local condition appeared to be satisfactory. There was no meningitis though the dura mater was thickened over the aperture in the middle fossa. Miliary tubercles were found scattered through the spleen and both lungs. There was no sign of tuberculosis of the other organs and the bronchial and mesenteric glands did not appear tuberculous.

Case III. J.D. aged 2 years. Patient was under treatment for tuberculosis of the retro-pharyngeal and deep cervical glands. There was nothing/

nothing suggestive of middle ear mischief - no otorrhoea or facial paralysis, mastoid glands not enlarged. Subsequently signs of tuberculosis of right apex developed together with signs of enlargement of the bronchial glands and later of laryngeal tuberculosis and a fatal termination ensued. Patient had been breast fed 9 months and there was no history of tuberculosis in the family.

Post Mortem, - shewed extensive consolidation of the right lung in the upper lobe with a small cavity the size of a pea in the front. The pleura over the apex was thick and laminated. Bronchial glands were caseous. The larynx shewed extensive ulceration of both aryteno-epiglottidean folds. The cervical glands were caseous in the right carotid and supra clavicular triangles. The Pericardium shewed a small patch of inflammation near the reflection from the vessels. Miliary tubercles were scattered throughout both lungs. Mesenteric glands were caseous. The right temporal bone was carious between the apex of the petrous portion and the tympanic cavity which contained caseous debris. This was examined and tubercle bacilli found in it. The membrana tympani was intact.



Case IV. E.F. aged 1 <sup>1</sup>/<sub>12</sub>. Patient admitted suffering from otorrhoea on right side of one months duration. A week after commencement of discharge there appeared a swelling over the mastoid. Patient was breast fed until admission and there was no family history of tuberculosis.

On Admission - general condition fair. Discharge foul smelling; slight swelling over the mastoid. No facial paralysis. Discharge examined for tubercle bacillus - negative. Examination of other organs revealed nothing of note. Patient was operated on, the antrum being found to be opened by a perforation high up and far back. Antrum filled with caseous debris and granulation tissue beneath which there was carious bone. Membrane had a single perforation of very large size. Operation was completed as in cases I and II. Scrapings from the granulation tissue were examined and found to contain tubercle bacilli.

Subsequently patient's general condition deteriorated and he was removed from hospital by his parents. Locally the wound did satisfactorily and remained dry. Prior to leaving hospital discharge commenced from left ear.

Case V./

Case V. P.S. aged 6. Eighteen months prior to admission facial paralysis occurred at the right side suddenly. This was followed soon after by discharge from the right ear. Gradually the glands in the neck became enlarged. The aural discharge has continued ever since. Patient's previous illnesses include "tabes mesenterica?" when 2 years old. No history of tuberculosis in the family. On admission there was absolute paralysis of right side of face; the cervical glands formed large masses below the right ear and over the mastoid. Glands were also felt in the anterior triangle on the left side. From the ear issued abundant foetid discharge. Examination of discharge shewed tubercle bacilli only after repeated examination. Four days after admission meningeal symptoms set in and death supervened fourteen days later. Prior to death lumbar puncture revealed presence of lymphocytosis and turbidity of the cerebrospinal fluid and tubercle bacilli were found in it after centrifuging. Permission for post mortem examination was withheld. The membrana tympani was completely destroyed. (See Chart IV.)

Case VI./

Case VI. E.B. aged 1<sup>9</sup>/12. Patient was admitted with history of diarrhoea and vomiting for a fortnight; a week later cough set in and had become urgent, gradual coma supervened and patient was almost comatose on admission. There had never been any facial paralysis or otorrhoea. Patient was breast fed until 1<sup>4</sup>/12. No family history of tuberculosis. On admission patient was almost comatose and became completely so in a few hours - death supervening within 12 hours. Post Mortem, - shewed acute pneumonic phthisis of both bases with early excavation of right base. Bronchial glands enlarged. On opening the skull the meningeal veins were found thrombosed extensively on both sides and there was haemorrhage over the left Rolandic area. On opening the temporal bones, caries was found on both sides, the middle ear containing thick pus, which on examination revealed presence of tubercle bacilli and streptococci.

Case VII. J.J. aged 2<sup>6</sup>/12. Patient admitted for gradual wasting for a year. She had had otorrhoea for four months. Facial paralysis had not been noticed. Enlargement of glands in neck for nearly a year. Family history - Mother died of Phthisis 1 year ago. Patient is youngest of 6, /



of 6, of whom 3 died, cause unknown. Patient was breast fed 7 months and then weaned on account of mother's health.

On admission - patient was in a state of very poor nutrition. There was almost complete paralysis of left side of face. From the left ear was an offensive discharge. The glands formed large masses on both sides of the neck. Some of the glands appeared to be softening but there were no actual abscesses. There was percussion dulness behind the sternum (manubrium). Masses of glands were felt in the abdomen and the liver was much enlarged. There were no signs of tuberculosis of the lungs.

Examination of aural discharge shewed bacilli in all films. Patient was removed by her guardians and died at home six months later.

Case VIII. G. H. aged 1<sup>6</sup>/12. Patient was admitted for tuberculous peritonitis and pulmonary tuberculosis of two months duration. He had had otorrhoea from left ear for three months. He had been breast fed 1<sup>1</sup>/12. No family history of tuberculosis. On admission in addition to signs of peritonitis and pulmonary tuberculosis patient had slight discharge from both ears. The/

The membranae were perforated on both sides. Tubercle bacilli were found in the discharge. There was no facial paralysis and no palpable glands round the ear. Patient became rapidly worse and died about a week after admission.

Post Mortem. Patch of tuberculous bronchopneumonia in right apex. Bronchial glands caseous. General adhesive tuberculous peritonitis. Mesenteric glands caseous. Liver shewed caseous area where the bowel was adherent to its surface. No signs of tuberculosis elsewhere except in left temporal bone which was carious in the region of the inner ear and mastoid, the tympani cavity being filled with debris.

Case IX. G.F. aged 1. Patient had history of otorrhoea on R. side for 3 months with enlargement of mastoid gland which had been lanced 2 months ago. Patient had been wasting for some months and had had a purpuric rash for 6 weeks. Patient was an only child and had been bottle-fed on patent foods entirely. Parents were not tuberculous.

On admission patient was wasted with yellowish waxy appearance. Over the mastoid was a discharging sinus and there was no discharge from the right/

right ear below which were enlarged glands. Membrane was intact. Large masses of glands were palpable in the abdomen and the spleen was palpable. The sinus over the mastoid was opened up and carious bone scraped. The antrum was filled with debris. This was examined and tubercle bacilli were found.

Subsequently pulmonary symptoms set in, Eustace Smith's murmur became audible and increased, and patient died 5 weeks after operation.

Post Mortem - extensive pneumonic phthisis of right upper lobe, patches of bronchopneumonic tubercle in both bases. Bronchial glands enlarged and firm. Mesenteric glands caseous, spleen enlarged and containing tuberculous nodules the size of a marble. Permission to open the skull was withheld.

Case X. W. E. aged 4/12. Breast fed one month. Mother has phthisis. Otorrhoea on R. side appeared when 2/12 quickly followed by swelling of glands behind and below the ear and later in parotid region. Facial paralysis set in 5 weeks ago.

On admission there was complete paralysis of right side of face. There was copious foul discharge containing tubercle bacilli in very large/



large quantities (10-15 in most fields). The membrane was completely destroyed, the meatus opening into a large cavity. A probe passed horizontally in encountered carious bone at a depth of 2". There was extensive enlargement of the glands below the ear and in the mastoid and parotid regions. The condition was considered to be too advanced to admit of radical operation and patient died about a month later.

Post Mortem, - Mesenteric glands caseous.

Miliary tubercles in both lungs. There were two collections of greenish pus in front of the sterno mastoid. The neighbouring glands were enlarged and caseous. In dissecting them up one opened into a large cavity with irregular sloughing walls. The inner wall was composed of the carious remains of the temporal bone. The external meatus opened directly into the cavity. The mastoid and tympanum were completely destroyed. (see Diagram. C.)

On opening the skull thickening was observed of the dura covering the tegmen antri which was carious. The bone forming the outer wall of the antrum and that forming the posterior wall of the external meatus was completely destroyed.

Case XI. V.D. aged  $5\frac{1}{2}$ . Patient has had enlarged glands in the neck on both sides and double otorrhoea (intermittent) since he was 10 months old. Patient was breast fed. Parents healthy but the mother's sister died of phthisis. No other history of tuberculosis.

On admission patient had discharge from right ear - none from left. The right membrane was completely destroyed and carious bone was felt in the middle ear. Tubercle bacilli were found in the discharge in small quantities. Patient was absolutely deaf on the right side and hearing was markedly impaired on left side. Patient had adenoids which were subsequently removed. Enlarged glands were found in the parotid region - where they had broken down and left a sinus - and below the ear in front of the sterno mastoid and also just behind that muscle. These glands were excised or scraped and found to be typical caseating tuberculous glands. The mastoid was opened up and the antrum found full of carious debris, the walls of the middle ear were carious. The carious bone was scraped and the middle ear packed from the external meatus.

Case XII./

Case XII. A.H. aged 2<sup>9</sup>/12. Swelling over left mastoid came on when 2<sup>7</sup>/12 followed soon after by discharge from the ear. History of night sweats for three months. Patient was breast fed 13 months. On admission - discharge from left ear, fluctuating swelling behind the ear. Enlarged glands running down posterior triangle. No facial paralysis, aural discharge contained tubercle bacilli in very large quantities. Examination shewed cogwheel breathing on left side, Eustace Smith's murmur present. Slight dulness over manubrium sterni. No palpable mesenteric glands.

The antrum was opened up and found to be filled with debris. It was cleared out and the complete operation performed. A caseating gland below the ear was scraped out and cleared.

#### DIAGNOSIS.

Of the above twelve cases it will be seen that no fewer than nine terminated fatally. In two cases the aural condition was not suspected until it was revealed on the post mortem table. It will also be seen that of the nine cases no less than eight had tuberculous lesions elsewhere, thus substantiating that the condition does not usually reveal itself prior to the commencement of dissemination. It is largely/



largely on this account that the prognosis is of such a gloomy character. Miliary tuberculosis might be expected to occur with frequency when the age incidence of the condition and the frequent association of miliary to bone tuberculosis be considered. In the present series it was seen on four occasions and the presence of meningitis in another case (No.V.), on which unfortunately no post mortem examination was held, points to its occurrence again.

Politzer, as has been already mentioned, is of opinion that the condition never undergoes spontaneous cure, and even casts doubt on the authenticity of such cases as have been reported cured.

The prognosis of the condition when it arises as a complication of phthisis no doubt largely depends on the course taken by the pulmonary condition; and since the condition most frequently complicates late phthisis - especially where there is cavitation - we can rarely expect to see recovery in such cases, although recovery in such cases has been reported by Milligan and others.

Of the general considerations which might be held to account for the bad prognosis of such cases as may be considered to be primary, the most important are the age incidence, the affection of bone, and the unsatisfactory results obtained by treatment/

treatment. It has been shewn that the condition when primary is more frequent in infants under two or three years of age than at any other time, and the feeble resistance to tuberculosis shewn by patients at this age and the frequency of miliary dissemination largely account for the frequency of a fatal issue. The affection of the bone is also of significance in view of the frequency with which miliary tuberculosis arises from a focus in bone.

The unsatisfactory results of treatment are unfortunately only too patent. Milligan states that "at least 40% of my cases of proved tuberculous infection have succumbed to the disease." In the present series the case mortality was at least 75%, though it is only fair to state that in 16% the condition was unsuspected and no local treatment had been employed. It does not come within the scope of the present paper to discuss treatment except in so far as it affects the prognosis. There are numerous reasons why operative interference does so little to reduce the case mortality. It must be remembered and this cannot be too freely insisted upon, that treatment is usually commenced too late, the condition is usually too advanced for half measures, and the patients are too young and usually too much reduced in strength, to stand extensive radical operative interference.

Amongst/

Amongst the factors regarded as of most evil omen by Milligan are the presence of extensive caries, facial paralysis, copious blood stained discharge, of massive enlargement of the lymph glands and the presence of tuberculous lesions elsewhere; and it will be observed that these are the very symptoms for the relief of which advice is sought. Briefly we may say that the insidious onset and the absence of pain are the causes of the high death rate, for the patient is rarely subject to treatment until the condition locally has become too advanced for cure or until the dissemination has become already established.

The presence of extensive disease in an infant at any age when radical operative proceedings are not well borne, and at which wide spread dissemination through the blood stream is prone to occur, affords little prospect of successful treatment. It must not be forgotten that some cases even at this early age if treated promptly may improve. Successful cases in which cure has resulted have been reported by Milligan and others even in patients during the first year of life. Of few other conditions can it be said with equal justice that the condition most favourable to prognosis is the early diagnosis of the disease.



## REFERENCES.

1. Young and Milligan - Journal of Laryngology. Sept. 1905.
2. Wilde - Aural Surgery 1853.
3. Toynbee - Diseases of the ear. 1860.
4. Eschle - Deutsch. Med: Woch: 1883.
5. Nathan - Deutsch: Archiv: f. Klin: Med; vol. XXXV.
6. Grimmer - Archiv: of Otol: vol. XXXI.
7. Milligan- Brit. Med. Jour. Vol.II 1895.
8. Wingrave- Journal of Laryngology. March 1903.
9. Knapp - Archiv. of Otol. 1894.
10. Goldstein Journal of Laryngology. March 1903.
11. Williams- Trans. Minn: Med. Soc. 1895.
12. Mc.Caw - Medical News. October 1901.
13. Oppikofer. Archiv of Otol: August 1905.
14. Jobson Horne- Journal of Laryngology. April 1903.
15. Hurd. - Archiv.of Otol: August 1905.
16. Schwabach - quoted by Goldstein (10)
17. Moldenhauer - Monatsch: f: Ohrenheilk: 1885.
18. Carr. - Med: Soc: Trans: Vol. XVII.
19. Still - Brit. Med. Jour. Vol. II 1899.
20. Schwabach - Loc. cit.
21. Milligan - Journal of Laryngology. March 1903.
22. Whitehead - Journal of Laryngology. March 1903.
23. Politzer - Diseases of the ear 4th Edit. 1902.
24. Brieger - 6th Internat. Congress. Otol: 1899.
25. Haug - Archiv. f. Ohrenheilkund: 1891.
26. Milligan - Med. Chronicle. Jan. 1896.

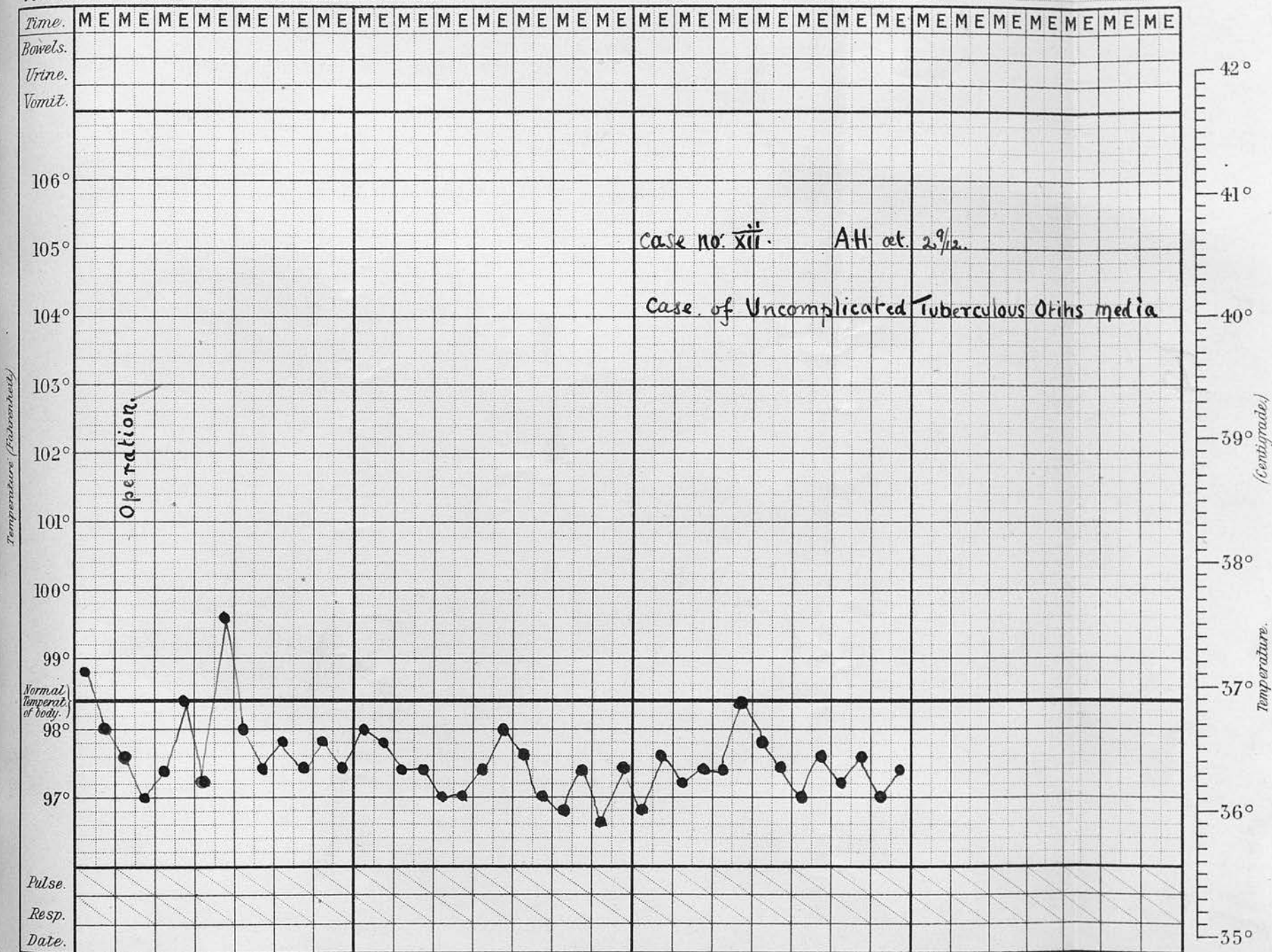
27. Habermann - Archiv. f. Ohrenheilk: 1886.
28. Jobson Horne- Brit. Med. Jour. Sept. 31<sup>st</sup> 1903.
29. Mc.Bride & Turner - Edin. Med. Jour. May 1897.
30. Pilliet - quoted by Mc.Bride & Turner.(29)
31. Dieulafoy - Bull. Acad. de Med. Paris. 1895.
32. Brindel - quoted by Mc.Bride & Turner (29)
33. Gottstein - Berlin. Klin. Wochenschr. Aug 1896.
34. Pfluder & Fischer - Archiv. f. Laryngol. u. Rhinol. 1896.
35. Milligan - Journal of Laryngol. March 1903.
36. Poirier & Cuneo - The Lymphatics - trans. Cecil Leaf.
37. Barnick - Archiv. f. Ohrenheilk: 1889.
38. Cornet - Tuberculosis - in Nothnagel's Practice.
39. Habermann - Archiv. f. Ohrenheilk. 1889.
40. Haike - Archiv. f. Ohrenheilk. Vol. XLVIII.
41. Kössel - Archiv. f. Ohrenheilk. 1894.
42. Jobson Horne- Journal of Laryngol. March 1903.
43. Macewen - Brit. Med. Jour. July 30 1904.
44. Mathews. -- Brit. Journ. Childr. Diseases. *March 1906.*
45. Urban Pritchard- Journal of Laryngol. April 1903.
46. Blake and Buck - New York Med. Journ. 1886.
47. Lake - Journal of Laryngol. May 1895.
48. Oppikofer - Archiv. of. Otol. August 1905.
49. Wingrave - Journal of Laryngol. March 1903.
50. Fraenkel - Brit. Med. Journ. June 14. 1902. Epitome.
51. Bullock - Trans. Brit. Congress. Tuberc. Vol. III.
52. Freysing - Archiv. of Otol. Oct. Dec. 1899.

53. Price Jones - Practitioner. Vol. LXXI.
54. Nathan Raw - Lancet. August 5th 1905.
55. Cheattle - Archiv. of Otology. Oct. Dec. 1899.
56. Wingrave - Journal of Laryngology. Vol. XII.
57. Milligan - 6th International Otolog. Congress 1899.
58. Milligan - Medical Press. March 4th 1903.
59. Grunert. - Munch. Med. Wochenschr. 1899.
60. Gaudier - Annales des Mals de l'Oreille - June 1899.
61. Lartigan & Nicol. - Amer. Journ. Med. Sci. June 1902.



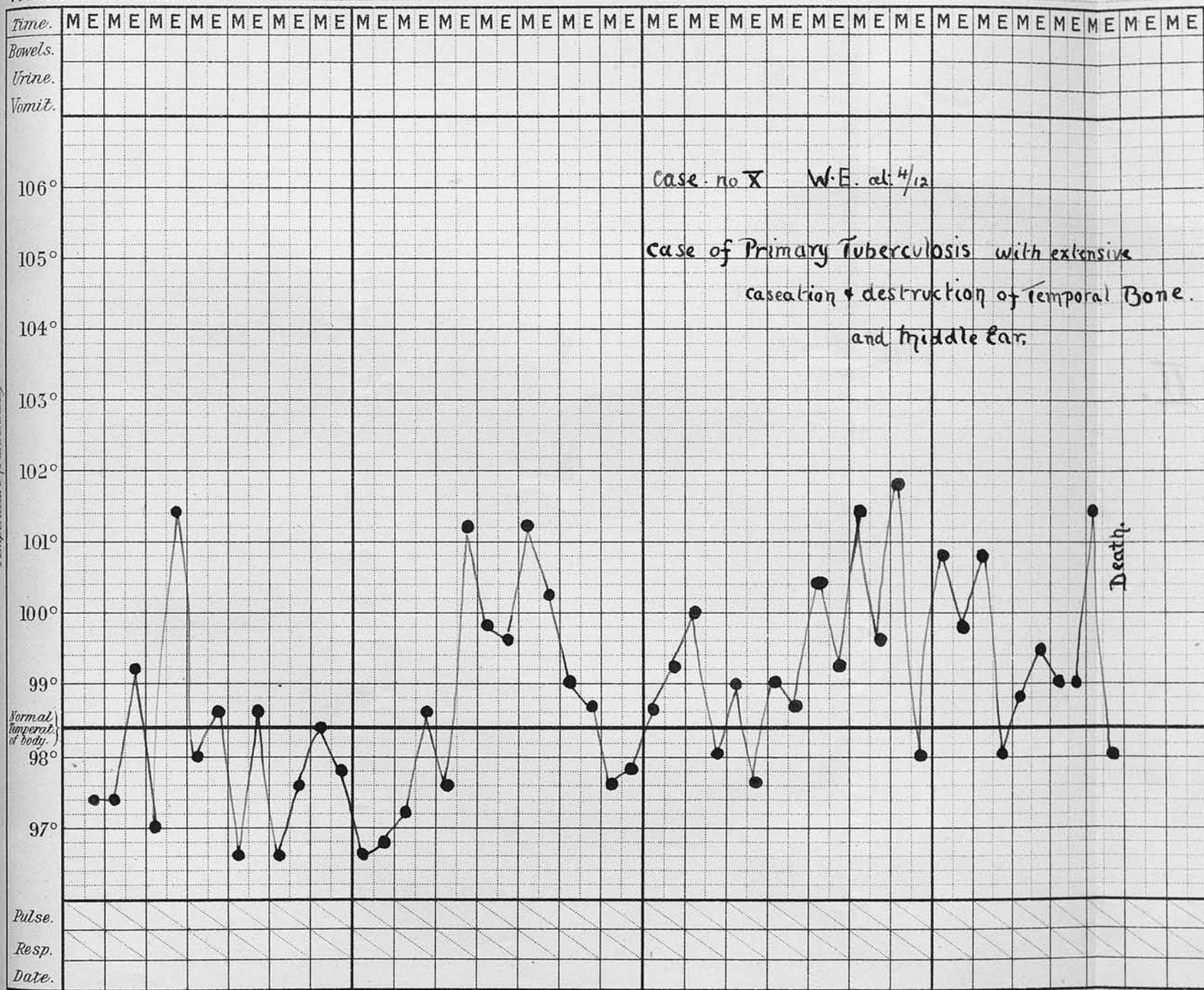
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NAME W. E. Case no. X

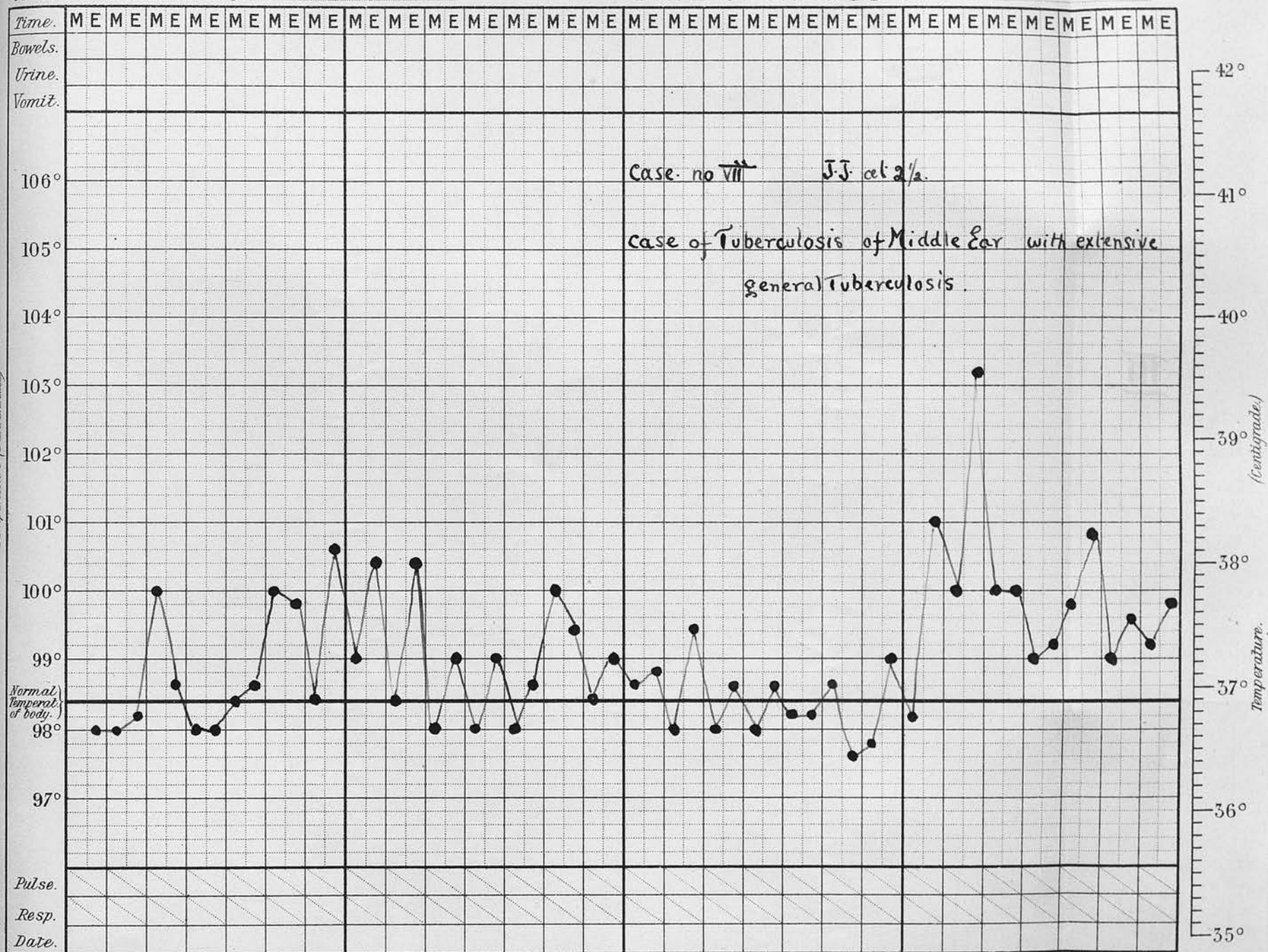
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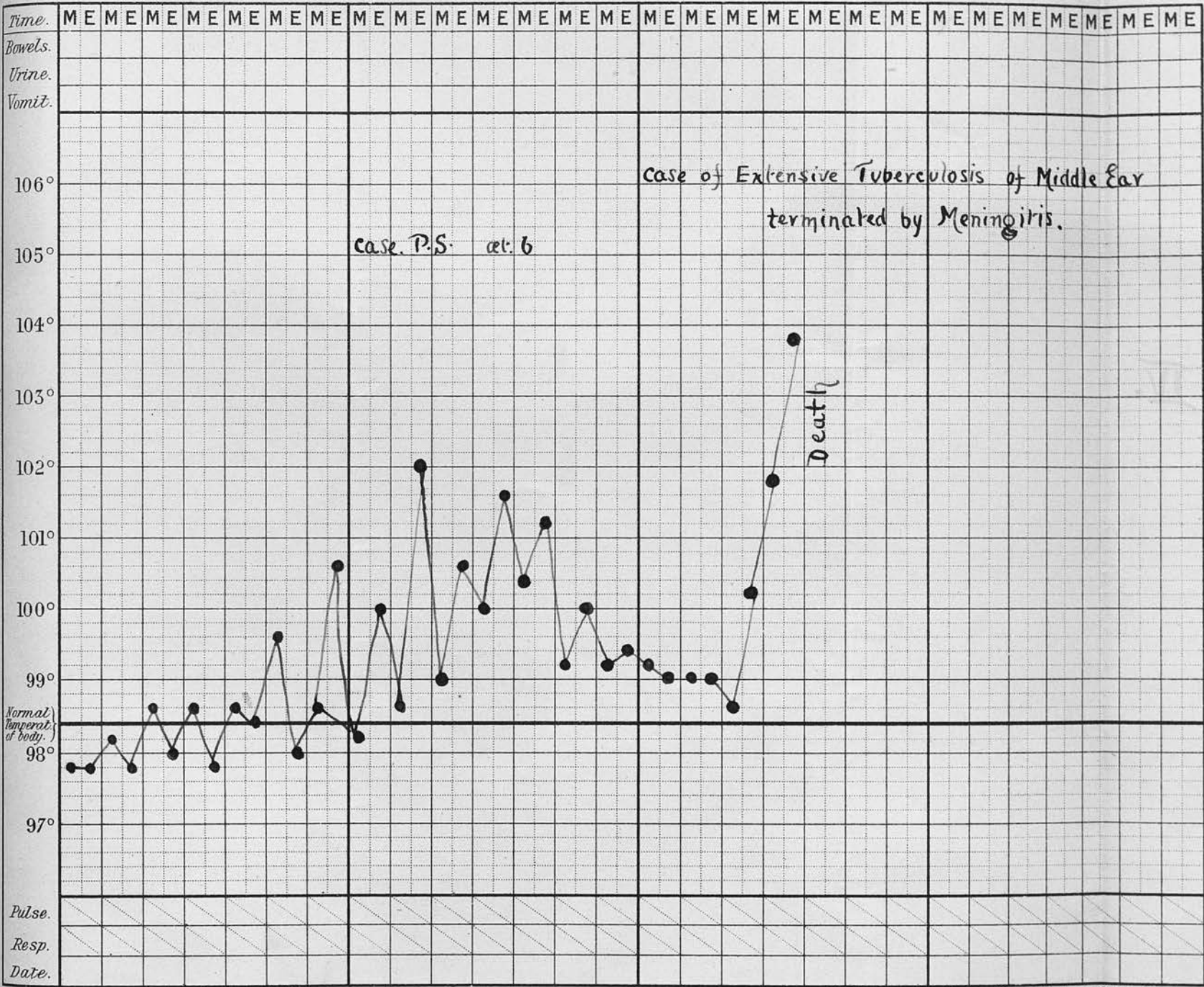
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case. P.S. at. 6

Case of Extensive Tuberculosis of Middle Ear terminated by Meningitis.

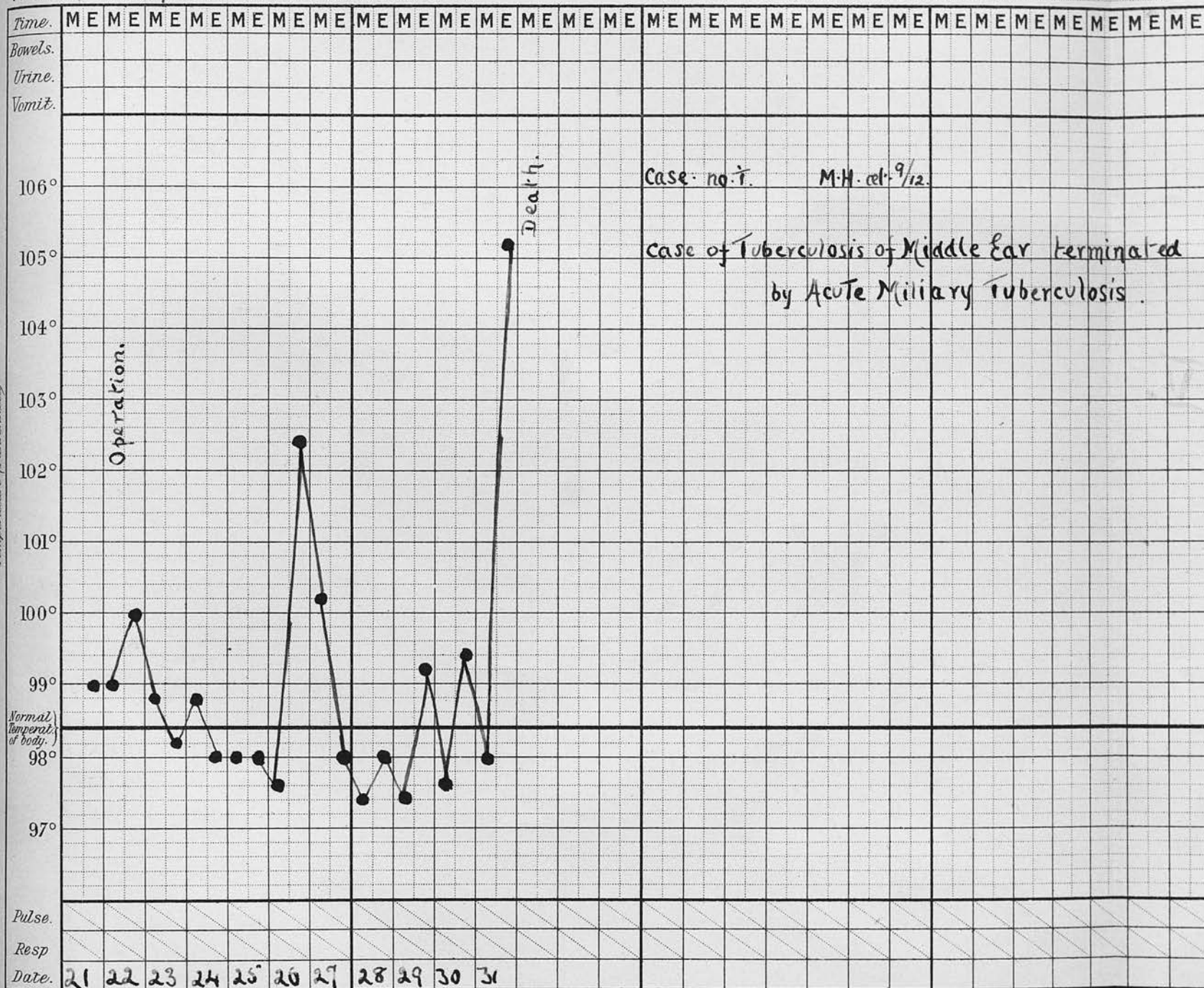
Death

Temperature (Celsius)  
42°  
41°  
40°  
39°  
38°  
37°  
36°  
35°

NAME M.H. case no i.

DATE OF ADMISSION

V.





NAME M. G. case no. II.

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VI

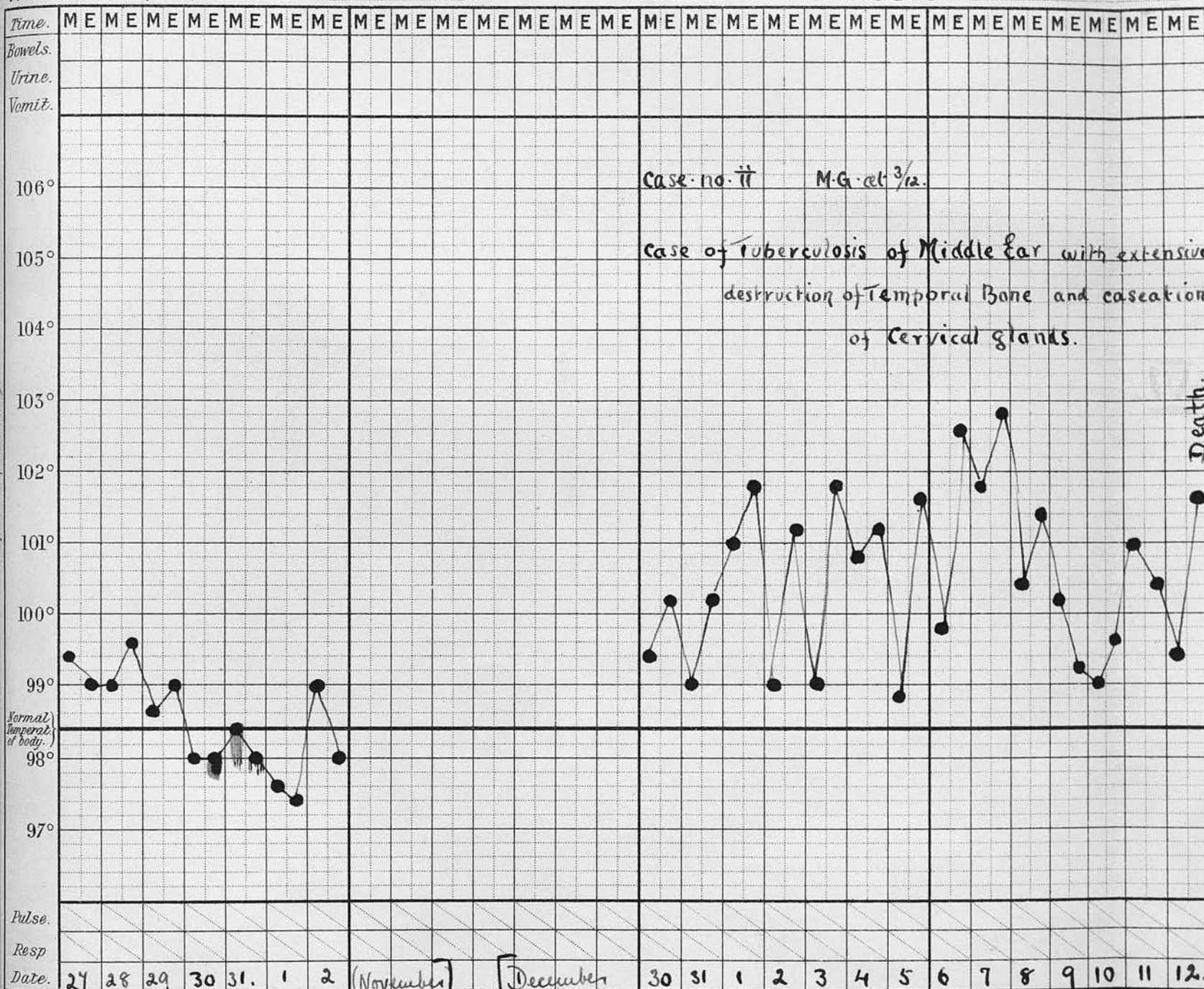
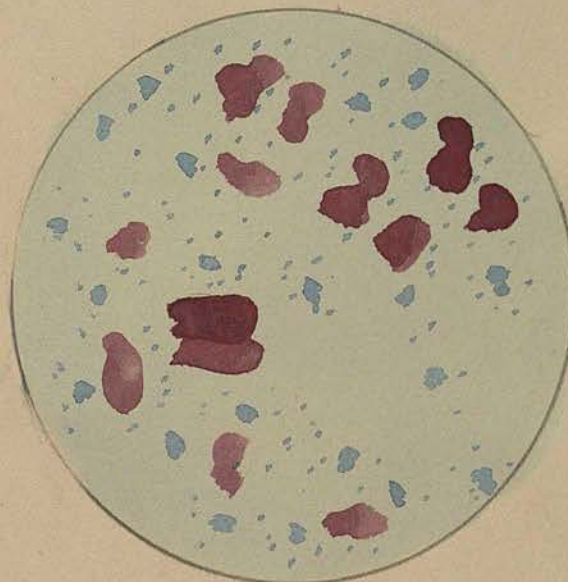
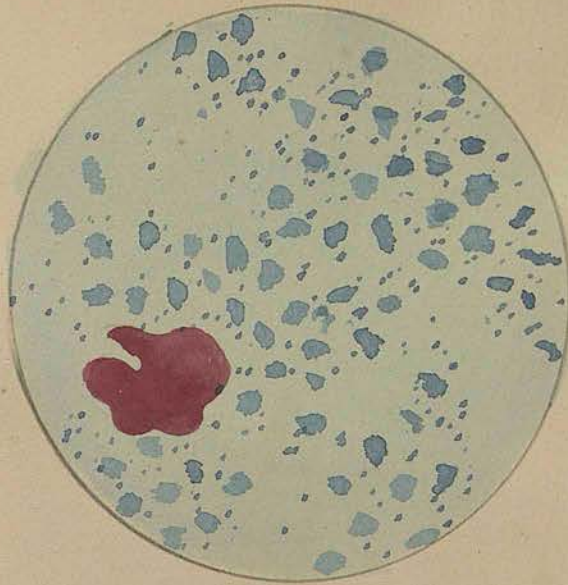




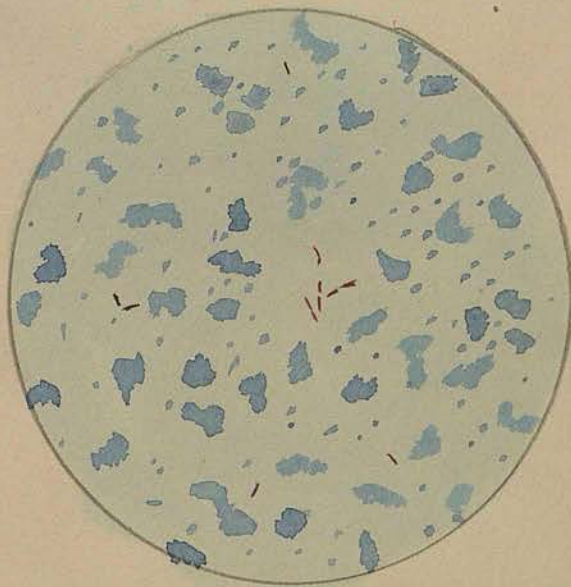
Diagram A.



Shewing acid-fast re-action of squames found in discharge  
from middle ear. From case of non-Tuberculous otorrhoea.

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Diagram . B .



Pus from case of Primary Tuberculosis of Middle Ear (Case, No: xii)  
showing numerous B. Tubercle.

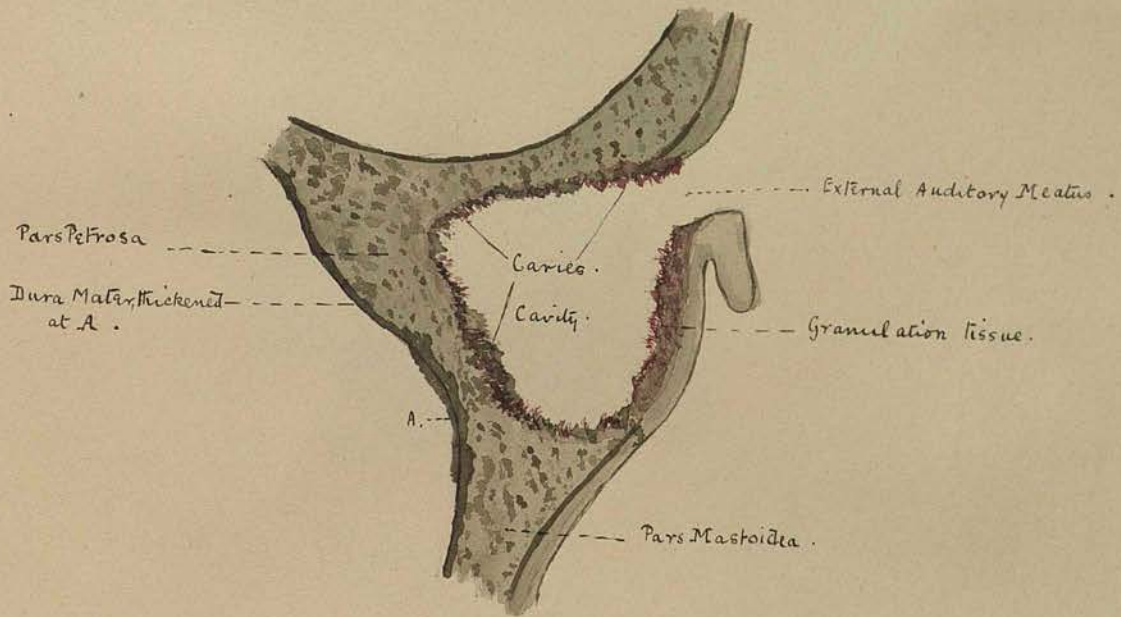
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ZIEHL-NEELSEN.

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Diagram. C.

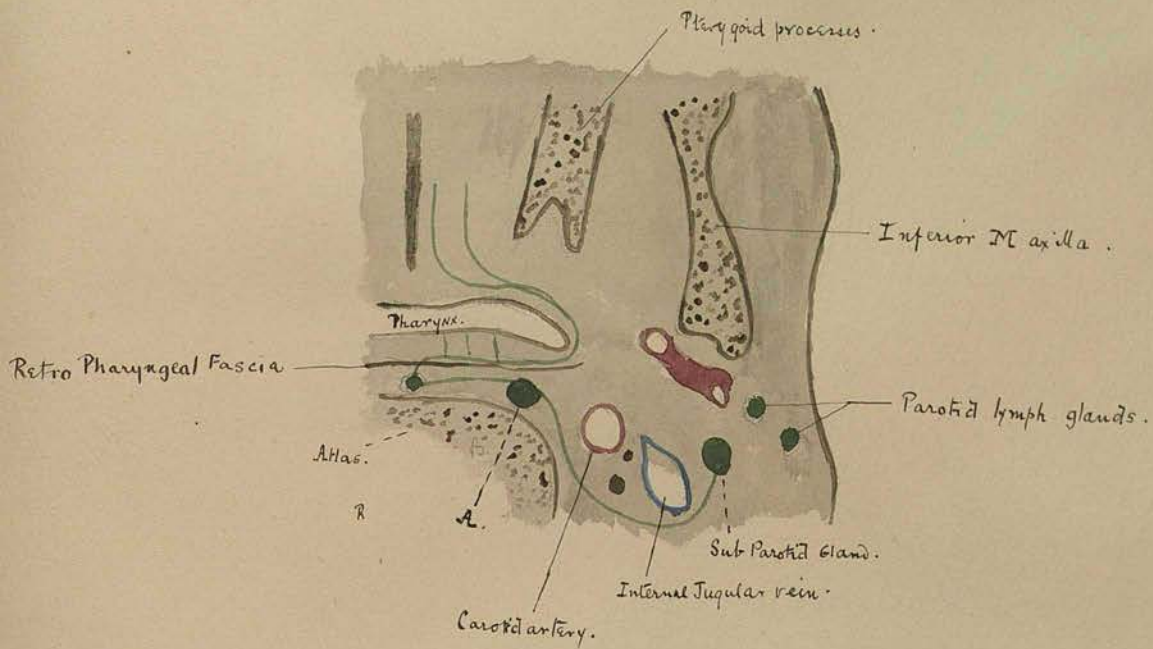


Horizontal section through Right Temporal bone of patient W.E. (case No. x.)  
showing extensive destruction of bone. &c.

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Diagram. D.



Shewing position of Retropharyngeal Glands (A.) They also receive afferents (not shewn in diagram) from Eustachian tube and Tympanic mucosa.

Fig: ii.

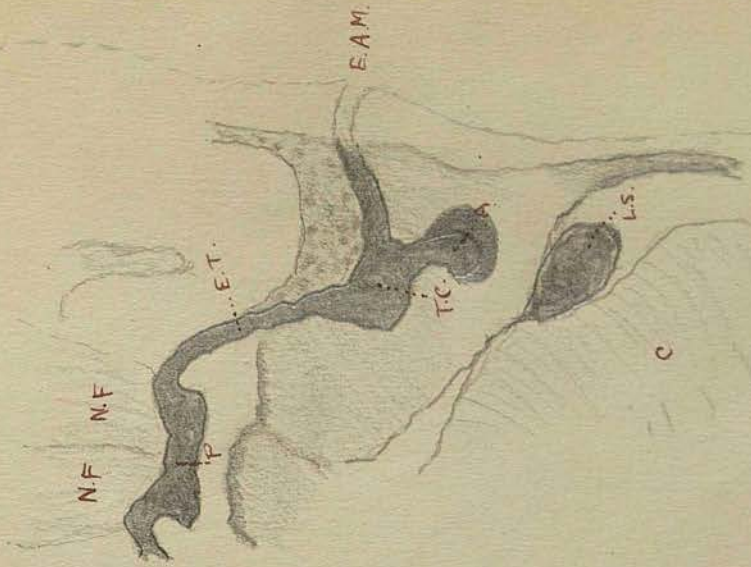


Diagram. E.

Fig: i.

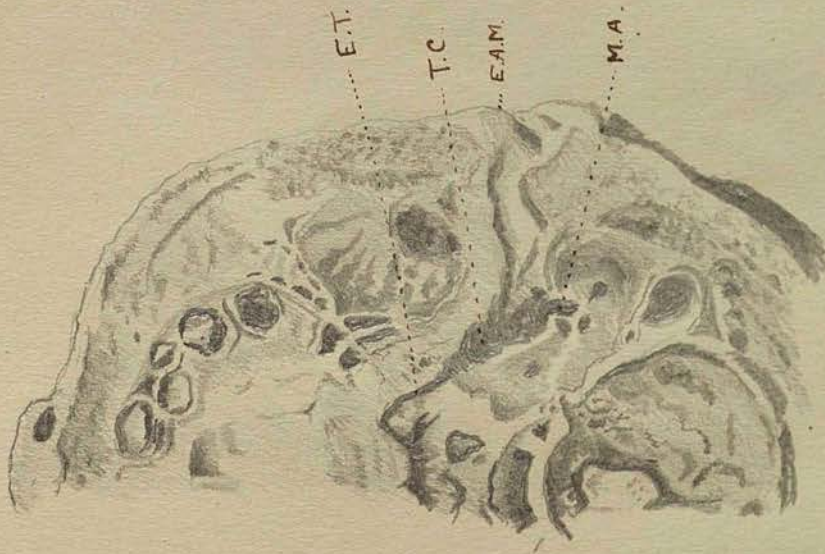


Fig: i. Horizontal section through head at level of Middle Ear shewing continuity of cavities of Middle Ear. From a child at birth.

Fig: ii. Diagrammatic enlargement to shew Middle Ear.